労災疾病臨床研究事業費補助金

企業・産業保健スタッフ・医療機関の連携による両立支援システムの開発

平成29年度　総括・分担研究報告書

主任研究者　松平　浩

平成30年3月

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Ⅰ．総括研究報告

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平成 29 年度総括研究報告書

企業・産業保健スタッフ・医療機関の連携による両立支援システムの開発

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研究要旨:大企業における両立支援への認識は、昨年「事業場における治療と職業生活の両立支援のためのガイドライン」の公表以降、高まりつつあるが、事業場数で 9 割以上を占める（労働者数 50 人未満の）中小企業への両立支援は未開拓分野である。事業場の課題は、労働者が就労を継続できるような就業上の措置を、がんの種類を含む疾病の固有性も考慮しつつ行うことであるが、両立支援という概念が浸透していない状態ではそれも難しい。中小企業への両立支援の普及を目的に、本年度は以下の 2 つのサブテーマに関して研究を実施した。

①ソーシャルマーケティングを加味した探索的統計手法による、対中小企業の両立支援活動評価指標案の作成:

労働者健康安全機構の「治療と就労の両立支援マニュアル」、分担研究者の横山が松平と共に前研究班で作成した「両立支援連携ガイドライン」、分担研究者の遠藤が作成した「企業の病休/復職制度等とがん/脳卒中の復職率等の評価指標の質問票」等の既存の成果物・調査票及び健康経営優良法人認定制度（中小規模法人部門）の評価項目をもとに、各疾患の専門家を交え中小企業に向けた効果指標を検討し、事業所に配布する質問票を作成した。

調査コホートとして、産業保健総合支援センター、中小企業産業保健事業の窓口である東京商工会議所、全国健康保険協会（千葉支部）、京都工場保健会等の協力のもと、11 月より 5,000 社に配布し、1,026 社より回答を得た。解析が完了した 576 社において、がん職員を有したのは 40%であり、その内約 7 割の会社で全員復職していた。全員復職していた 576 社では「両立支援についての社員に教育、啓発が進んでいる」「社員が相談できる窓口がある」「職場が両立支援に理解がある」などの特徴を持つことが明らかになった。

②機構の両立支援コーディネーターと両立支援促進員、社労士等を対象とした質的研究による各専門職/スタッフの支援モデル案の作成：

各専門職スタッフの支援モデルの作成に関しては、フォーカスグループインタビュー調査を実施した。分担研究者の高橋をインタビューアーに、がんの両立支援に携わる中小企業側：社会保険労務士・経営者、病院側：両立支援コーディネーター・理学療法士・作業療法士・看護師、企業と病院のハブ的立場：産業保健総合支援センター所長を対象者とした。この結果、治療、離職、復職といったタイミングの違いによる必要な支援内容の違いや、相談する人（患者・従業員サイドと企業サイド）によって相談しやすい窓口の設置場所の違いなどの問題点が考えられた。

＜研究分担者＞
順天堂大学公衆衛生学講座/准教授 遠藤源樹
京都工場保健会産業医学研究所/所長 森口次郎
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石川産業保健総合支援センター/所長　小山善子
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順天堂大学/教授 横山和仁

A. 研究目的

国立がん研究センターの推計にて、年間約 100 万人が新たながんと診断され、その 3 割が就労世代である。少子高齢化に伴う人材難による定年年齢の引き上げ、働く女性の増加と乳がん罹患者の増加等から、がん罹患労働者、特に医療の進歩を背景にしたがんサバイバー労働者は急増することが見込まれる。

大企業における両立支援への認識は、昨年「事業場における治療と職業生活の両立支援のためのガイドライン」の公表以降、高まりつつある。平成 28 年度末には、労働者健康安全機構が「治療と就労の両立支援マニュアル（がん、脳卒中リハ、糖尿病等)」を公表、また今回の分担者の横山は前研究班で「両立支援連携ガイドライン（がん、糖尿病、難病等)」を作成しており、産業保健スタッフが充実する大企業への両立支援は、機構等において、本年度から実践、周知、普及のフェーズに入ったといえる。

しかしながら､事業場数で 9 割以上を占める(労働者数 50 人未満の）中小企業への両立支援は未開拓分野である。事業場の課題は、労働者が就労を継続できるような就業上の措置を、がんの種類を含む疾病の固有性も考慮しつつ行うことであるが、両立支援という概念が浸透していない状態ではそれも難しい。

本研究では、中小企業へむけた両立支援の普及を目標に、以下の３つのサブテーマを設定した。

①ソーシャルマーケティングを加味した探索的統計手法による対中小企業の両立支援活動評価指標案の作成（H29～30 年度）

②機構の両立支援コーディネーターと両立支援促進員、社労士等を対象とした質的研究による各専門職/スタッフの支援モデル案の作成(H29～30 年度)

③両立支援版の評価指標と中小企業のための治療と職業生活の両立支援マニュアルの提案（H31 年度)、

本年度は①②に着手し、3 年計画で研究を遂行する。

さらに、がんを含めた生活習慣病の重症化予防も両立支援の重要な範疇であるため、副次的研究として、多くの疾病の治療と重症化予防、高齢労働者のヘルスプロモーションとしてエビデンスがありながら､実践が容易ではない運動/ACT に注目し、その両立支援コンテンツの開発（29～30 年度）と、連携モデルでの実践・検証とマニュアルの提案を行う（31 年度)。

なお研究代表者である松平と分担研究者の岡は全ての分担研究に参画し、研究デザイン・統計解析を行っている。

B. 研究方法

①ソーシャルマーケティングを加味した探索的統計手法による対中小企業の両立支援活動評価指標案の作成

復職・離職・休業に関する効果指標を選定するにあたり、ガイドラインで取り上げられる主要疾患の職場で配慮すべき事項は、労働者健康安全機構の「治療と就労の両立支援マニュアル」、分担者の横山が松平と共に前研究班で作成した「両立支援連携ガイドライン」にて検討済みである。さらに分担者の遠藤は企業の病休/復職制度等とがん/脳卒中の復職率等の評価指標の質問票を作成し、全国70社からデータを収集した実績を持つ。本研究では、上述した既存の成果物・調査票及び健康経営優良法人認定制度（中小規模法人部門）の評価項目をもとに、各疾患の専門家（研究分担者：遠藤、野村、協力者：豊田、黒澤）も交え中小企業に向けた効果指標を検討し、事業所に配布する質問票を作成した。

作成した調査票を石川産業保健総合支援センター、一般財団法人京都工場保健会、全国健康保険協会千葉支部、東京商工会議所サービス・交流部の協力のもと 11 月より 5,000 社に配布し、回収・解析を行った。

②機構の両立支援コーディネーターと両立支援促進員、社労士等を対象とした質的研究による各専門職/スタッフの支援モデル案の作成

【対象】10 名の専門職（社会保険労務士 3 名、中小企業事業主 1 名、労災病院 MSW(両立支援コーディネーター)、東大・リハ部 OT/PT、NS、産保センター所長（医師））

【場所】東京大学教育学部棟2階第1会議室

【調査】フォーカスグループインタビュー

【予備調査】参加者の社労士1名、OT1名に予備インタビューを実施（1～1.5時間）

【本調査事前手続き】事前に以下を送付

1. 研究主任者からのメッセージ
2. 参加者のプロフィールを収集・共有
3. インタビューガイド・両立支援基礎情報送付

（倫理面への配慮）

①東京大学倫理委員会等にて、審査番号 11729「企業・産業保健スタッフ・医療機関の連携による、がん患者の治療と就労の両立支援システムの開発」として承認を得て、研究を実施している。本研究課題は、各種法令等、特に「人を対象とする医学系研究に関する倫理指針」および、東京大学が定めた倫理規定を遵守して行う。

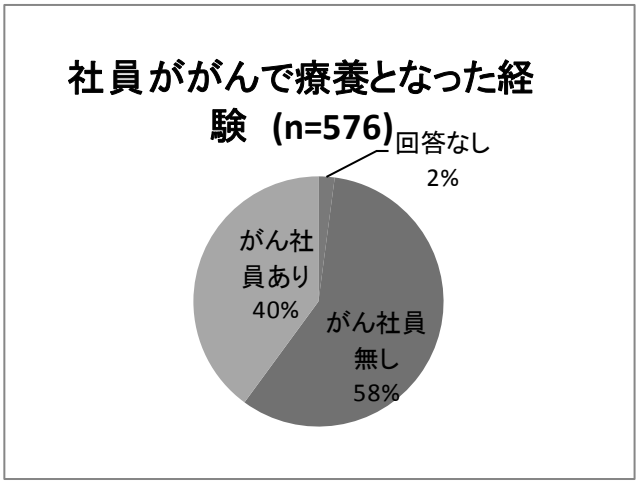
②人を対象とする医学系研究に関する倫理指針に基づき、東京大学ライフサイエンス研究倫理支援室にて倫理審査を受けている。

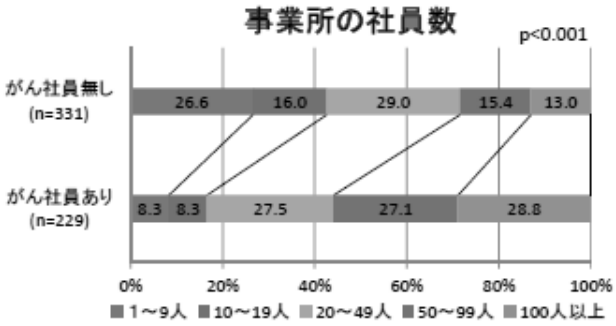
C. 研究結果

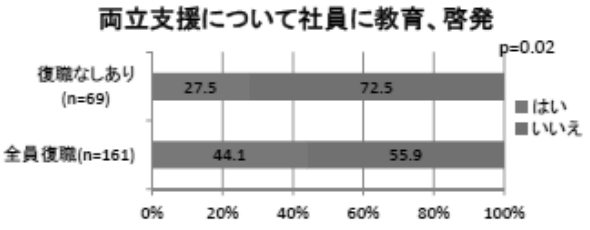
①ソーシャルマーケティングを加味した探索的統計手法による対中小企業の両立支援活動評価指標案の作成

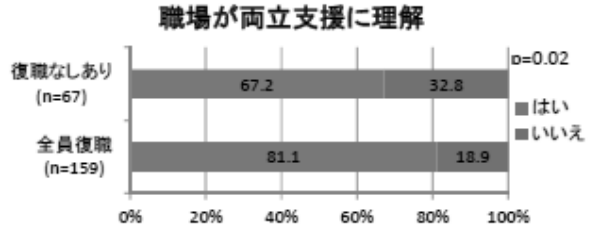
11 月より 5,000 社に配布し、1,026 社より回答を

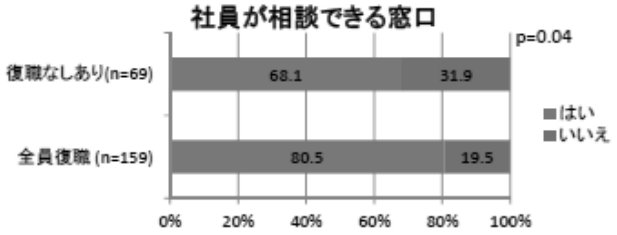
得た。解析が完了した 576 社において、がん職員を有したのは 40%であり、その内約 7 割の会社で全員復職していた。全員復職していた 576 社では「両立支援についての社員に教育、啓発が進んでいる」「社員が相談できる窓口がある」「職場が両立支援に理解がある」などの特徴を持つことが明らかになった。

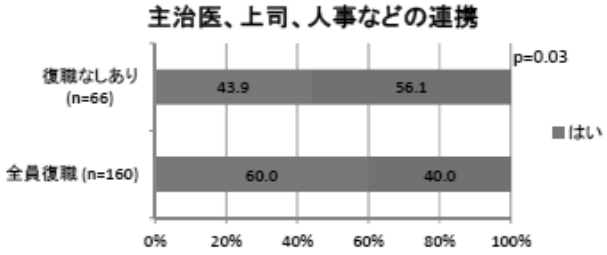












②機構の両立支援コーディネーターと両立支援促進員、社労士等を対象とした質的研究による各専門職/スタッフの支援モデル案の作成

文字起こしをしてそれを読み込み、重要ラベルの作成、分類をしてカテゴリを作成した。

分析の結果, 7つのカテゴリ, 22のサブカテゴリ, 220の重要アイテムが生成された。

なお，治療や就労の状況に応じて，がん診断直後後の「Ⅰ．初期治療」，手術・退院・復職を経て「Ⅱ．復職を考える」，病気が寛解して再発・病勢増悪する「Ⅲ．復職後の日々」の3つの時期が見出された。問題として、3期にわたって、以下の5つの問題点が抽出された。

「Ⅰ．初期治療」の段階：＜問題①病院内（両立

支援）システムが整備されていない＞
＜問題②企業内（両立支援）システムが機能していない＞
＜問題③医療－企業間の連携不足＞
「Ⅱ．復職を考える」の段階：＜問題④院内連携の不足＞,
＜問題⑤産保センターの機能不全＞,
＜問題⑥ハブ機能を持つ機関の「不在」と「乱立」＞、
「Ⅲ.復職後の日々」に＜問題⑦長期的な支援の難しさ＞が見い出された。

D. 考察

2018 年度の診療報酬改定答申にがん治療と仕事の両立を目指し、がん治療と仕事の両立を診療報酬で評価すると記載された。このような取り組みが広がり、人員確保にも寄与することが期待される。また、保健師などの事業所内スタッフによるケアが高いニーズがある。両立支援を推進するにあたっては小規模事業場の産業医選任助成のような、保健師選任助成も対策として選択肢の一つとして考えられる。事業場での保健師選任が進めば、その他の課題である、不安感への対応や具体的な支援方法にも柔軟に対応できる可能性がある。

治療と就労の両立支援は、医療側と職場側に分断されて行われており、その各々において十分な対応がなされていないことが示唆された。また、それによって、結果的に患者（就労者）自身が両立のための情報を収集しなければならない状況にあることが示された。さらに、現状では、がん相談支援センターや産保センターなど、医療側と職場側の窓口となるべき機関が存在はしているものの、いずれも十分に機能しておらず、場所によってはハブ機能が不在であったり、あるいは存在していたとしても混乱があることが示唆された。さらに、がん告知や復職時だけでなく、中長期的な支援が必要とされていることが示されたが、「初期治療」「復職を考える」時期に十分な支援が確立していないため、その後「復職後の日々」の長期的な支援まで行き届いていない現状があることが示唆された。

E. 結論

両立支援は、患者（就労者）が治療ルートの中で無理なくつながることができる入り口を設けること、さらに、中長期的な支援のためには、様々な専門家から必要なタイミングで支援が受けられるような連携が必要である。

F. 健康危険情報

該当なし

G. 研究発表

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2. 学会発表

なし

H. 知的財産権の出願・登録状況（予定を含む）

1. 特許取得

なし

2. 実用新案登録

なし

3. その他

Ⅱ.分担研究報告

労災疾病臨床研究事業費補助金

平成29年度分担研究報告書

脳卒中における病休・復職制度に関する実態調査と選択制がん等罹患社員就業規則標準フォーマット

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研究要旨

単一事業所を対象に、総務・人事担当者に質問票を配布後、メール等で回収し、就業規則、身分保障日数や復職支援制度の実態と脳卒中罹患社員の復職後の状況、企業規模による制度の違いについての実態調査を行った。全社員数が 100 人未満の企業は全社員数が1000 人以上の企業に比べて、復職時にフルタイム勤務を原則としている企業が多かった。100 人未満の企業における復職に関する手続きは、1000 人以上の企業に比べて本人の意思を重視し、会社の許可や産業医の意見を必要としている企業の割合が少なかった。身分保障日数は、勤続年数が増えるに従い、身分保障日数が増えていた。復職支援制度に関しては、現在導入されている制度で多いのは短時間勤務制度や時差出勤・フレックスタイム制度であり、少ないのは在宅勤務制度、退職者の再雇用制度であった。今後導入できる可能性のある制度においても短時間勤務制度、勤務日数削減制度が多く、在宅勤務制度、退職者の再雇用制度は少なかった。いずれの制度も、非正規社員に対しては、正社員より、導入されている制度も、今後導入可能性のある制度も少ないことが示され、正社員と非正規社員の間に、両立支援における制度の格差を認めた。本調査の結果から、産業医の配置や多様な勤務形態が可能な環境整備の充実に向けて具体的で実行可能な方法を提示すること、とりわけ 100 人未満の中小企業や非正規社員への支援を充実させることが重要であると考えられた。

A．研究目的

企業に勤める労働者が脳卒中と診断されて療養することによって、一時的に労働不可に陥った場合の状況、労働者の職場復帰状況・制度等を明らかにし、労働者の離職防止及び職場復帰の効果的な支援方法についての課題を把握することを目的とした。また、がん等罹患社員が治療と就労を両立しやすい職場づくりの一助となるよう、選択制がん等罹患社員就業規則標準フォーマットを作成することも目的とした。

B．研究方法

企業と業務契約のある産業医、社労士等に質問紙、メール等により配布し、メール等で回収した。

1．調査期間

平成 29 年 4 月～12 月（現在も継続中）

2．調査対象

単一事業所

3．調査結果について

報告書において、割合を算出するにあたり、集計結果の数値を少数第１位で切り捨てを行った。そのため、各回答の合計が 100%に

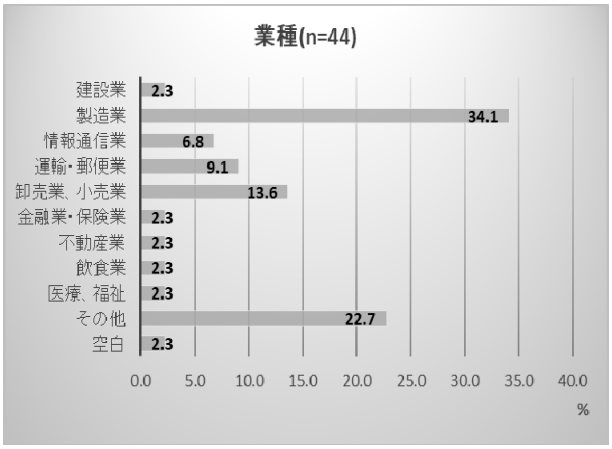
一致しない結果が認められる。また、複数回答についてはその項目毎に割合を算出した。

C．D．研究結果と考察

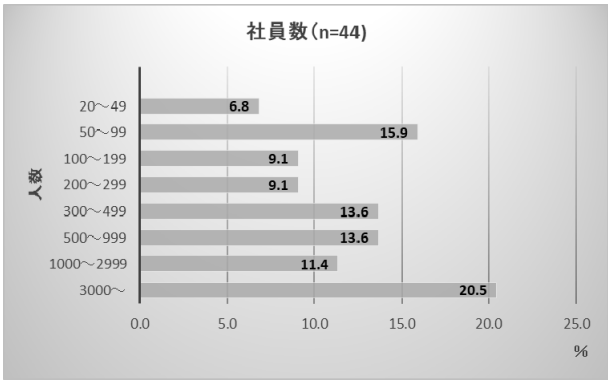
（1） 回答した企業の属性（単一回答）

回収した 44 社の主な業種は、多いものから順に製造業（34.1%）、卸売業・小売業（13.6 %）、運輸・郵便業（9.1%）、情報通信業（6.8%）で、その他の業種に回答した企業が 22.7 %であった（図 1）。その他の業種はサービス業、派遣業などの業種が認められた。

企業全体の社員数は、3000 人以上が 20.5%と最も多く、ついで 50~99 人（15.9%）、300~499 人と 500~999 人が 13.6%であった（図 2）。事業所の全社員数は 6 人～2344 人、事業所の正社員数は 4 人～3021 人と幅があった。



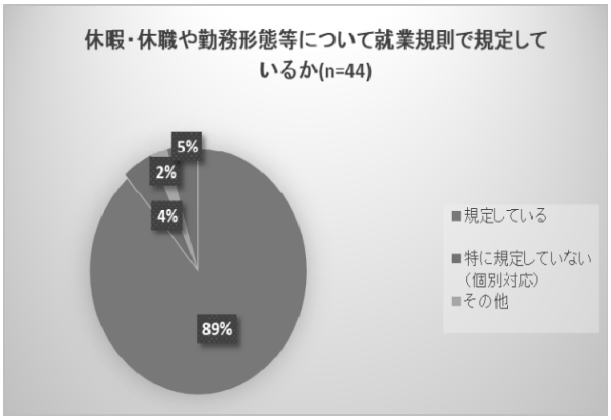
（図 1 ：回答した事業所の業種の割合）



（図 2：回答した事業所の社員数の割合）

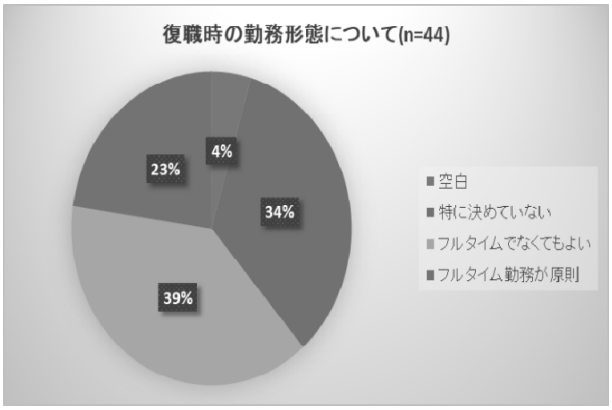
（2） 従業員が、療養が必要になった際の休暇・休職や勤務形態についての就業規則と復職時の勤務形態について（単一回答）

従業員が、療養が必要になった際の休暇・休職や勤務形態について、就業規則で規定しているかどうかについて、89%の企業が規定していると回答した（図 3）。



（図 3：休暇・休職時の勤務形態の就業規則）

復職時の勤務形態についてはフルタイムでなくてもよいと答えた企業が 39%で最も多く、ついでフルタイム勤務が原則と答えた企業が 23%、特に決めていない、個別対応の企業が 34%であった（図 4）。

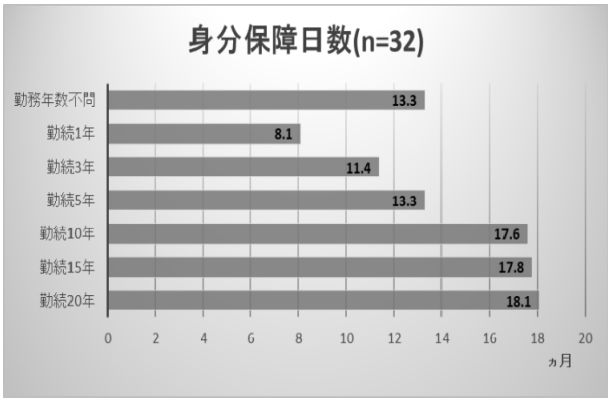


（図 4：復職時の勤務形態について）

（3） 身分保障日数

身分保障日数は、最も短い企業で 3 ヶ月から、最も長い企業で 39 ヶ月であったが、勤続年数が長くなるほど、身分保障日数が長くなることが示された。勤続年数別に身分保障期間を各企業の身分保障日数の平均値を算出した。その結果、勤続 1

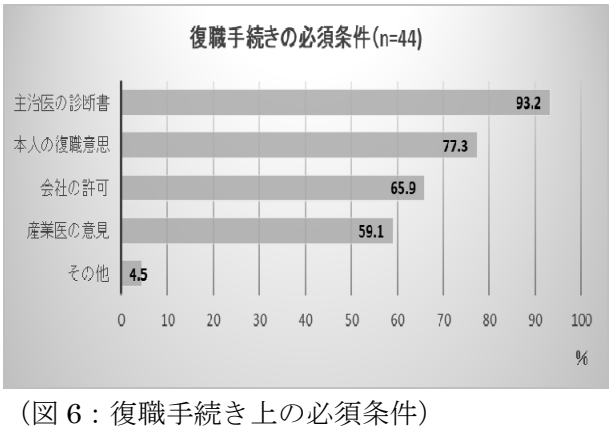
年が 8.1 ヵ月、勤続 10 年が 17.6 ヵ月、勤続 15 年が 17.8 ヵ月、勤続 20 年が 18.1 ヵ月であった。また、勤続年数不問で平均 13.3 ヶ月であった（図５）。



（図 5：勤続年数別身分保障日数（月））

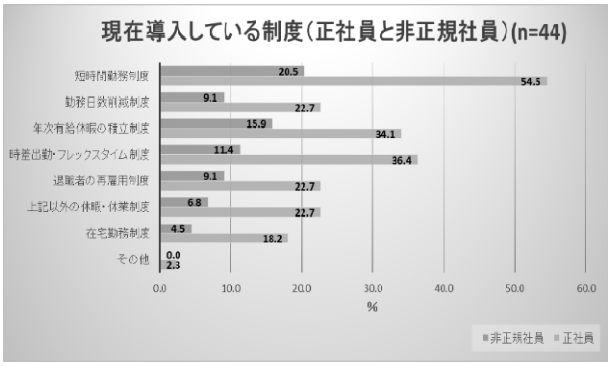
（４） 各企業の復職時の手続き上の必須条件について（複数回答）

各企業の「復職の手続き上の必須条件（複数回答）は何ですか」と聞いたところ、「主治医の診断書」（93.2%）、「本人の復職意思」（77.3%）、「会社の許可」（65.9%）、「産業医の意見」（59.1%）と回答した（図 6）。



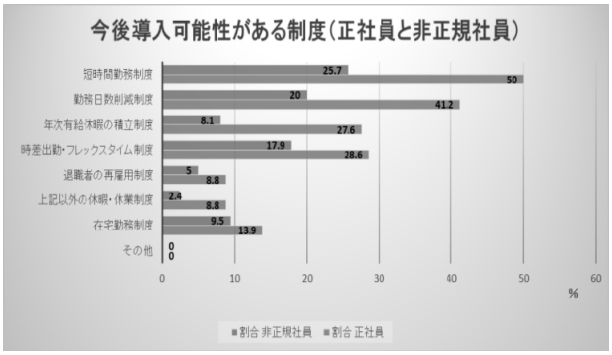
（図 6：復職手続き上の必須条件）

（５） 療養となった社員の復職支援制度に関して、「現在導入している制度」と「今後導入可能な制度」はありますか。（複数回答）



（図 7：現在導入している支援制度）

復職支援制度に関しては、「現在導入している制度」（複数回答）（図 7）で最も多いのは正社員・非正規社員ともに「短時間勤務制度」（正社員：54.5%、非正規社員：20.5%）、ついで正社員は「時差出勤・フレックスタイム制度」（正社員：36.4%）、「年次有給休暇の積立制度」（34.1%）であった。非正規社員は「短時間勤務制度」に続いて「年次有給休暇の積立制度」（15.9%）、「時差出勤・フレックスタイム制度」（11.4%）であった。いずれの制度に関しても非正規社員は正社員に比べて支援が少ないことが示され、在宅勤務制度がある企業は正社員、非正規社員ともに最も少ないことが示された。

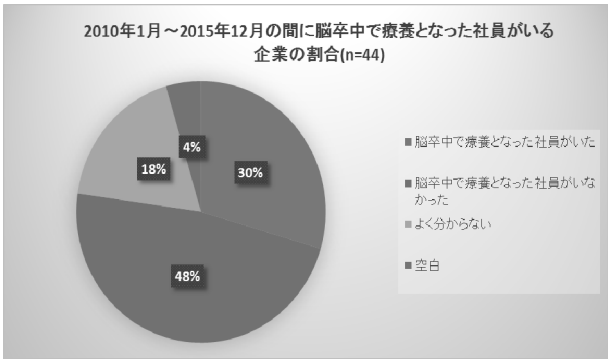


（図 8：今後、導入の可能性がある制度）

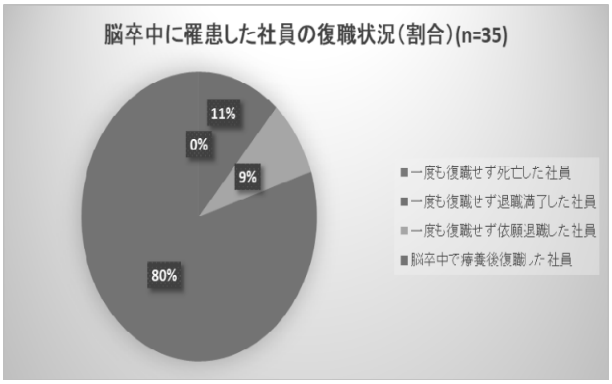
現在は導入されてないが、「今後導入の可能性がある制度」（複数回答）については（図 8）、正社員、非正規社員ともに「短時間勤務制度」（正社員：50%、非正規社員：25.7%）、「勤務日数削減制度」（正社員：41.2%、非正規社員：20%）、「時差出勤・フレックスタイム制度」（正社員：28.6%、非正規社員：17.9%）であった。次いで正社員は「年次有給休暇の積立制度」（27.6%）、非正規社員は「在宅勤務制度」（9.5%）であった。今後導入可能な制度に関しても、非正規社員は正社員に比べて今後導入可能な制度も少ないことが示唆された。

（6） 過去 6 年間について（2010 年 1 月～2015 年 12 月）に、脳卒中で療養となった社員の有無と療養後の復職状況について（単一回答）

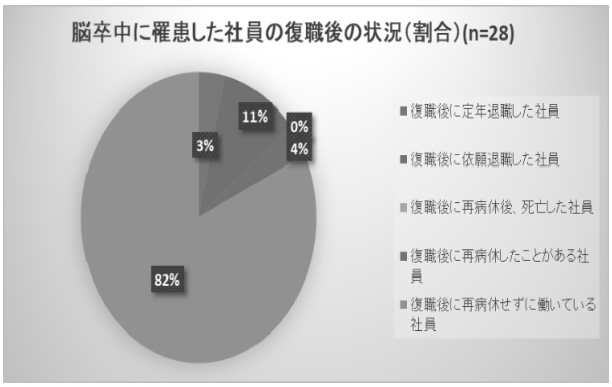
過去 6 年間（2010 年 1 月～2015 年 12 月）に、脳卒中で療養となった社員がいた企業は 30%であった（図 9）。脳卒中に罹患した社員については、80%の社員が「脳卒中で療養後に復職」（図 10）し、そのうち、82%の社員が「復職後に再病休せずに働いている」こと（図 11）、復職後に再病休した社員は 4%であった（図 11）ことが示された。



（図 9：2010 年 1 月～2015 年 1 月の間に脳卒中で療養となった社員がいる企業の割合）



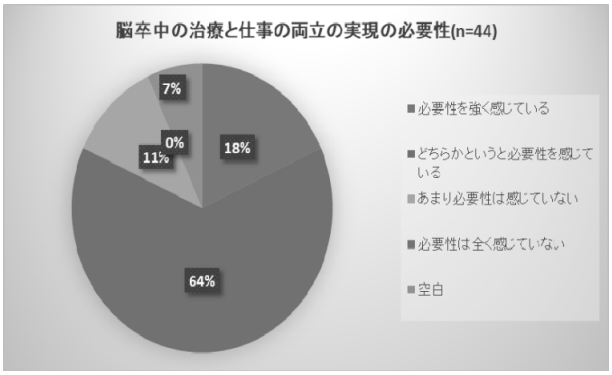
（図 10：脳卒中に罹患した社員の復職状況）



（図 11：脳卒中に罹患した社員の復職後の状況）

（7） 脳卒中の治療と仕事の両立が実現できる職場づくりへの必要性（単一回答）

脳卒中治療と仕事の両立の必要性について、最も多い回答が「どちらかというと必要性を感じている」が 64%と半数を占め、「必要性を強く感じている」は 18%、「あまり必要性は感じていない」は 11%であった（図 12）。「必要性は全く感じていない」は 0%であった。



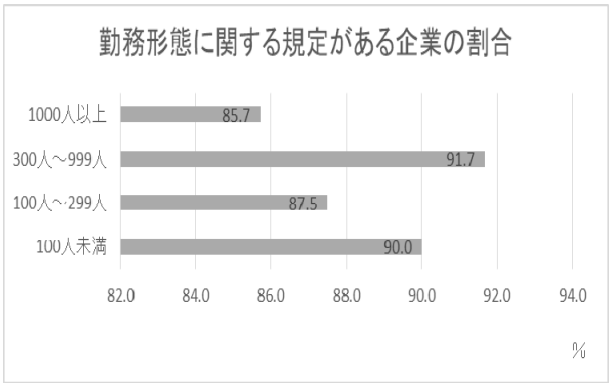
（図 12：脳卒中の治療と仕事の両立の実現が必要だと感じている割合）

（８） 企業の規模による解析

企業全体の社員数から①１～99 人（100 人未満）、②100～299 人、③300 人～999 人、④1000 人以上の４つに群分けを行って、4 つの群による違いを検討した。その結果、100 人未満が 10 社、100~299 人が 8 社、300~999 人が 12 社、1000 人以上が 14 社であった。

Q4 従業員の療養が必要になった際の休暇・休職や勤務形態等について就業規則で規定しているか。（図 13）

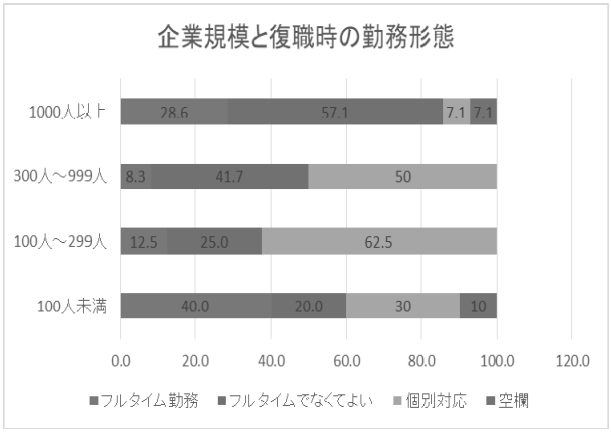
従業員が、療養が必要になった際に、休暇・休職や勤務形態についての就業規則での規定は、従業員数が 300 人～999 人の企業が 91.7 %と最も多く、ついで、100 人未満の企業が 90.0% であった。（100 人未満:n=10、100~299 人:n=8、300~999 人:n=12、1000 人以上:n=14 であった）



（図 13 : 企業規模と勤務形態に関する規定がある企業）

Q6 復職は、フルタイムが原則ですか、短時間勤務でもみとめられますか（図 14）。

フルタイムでなくてもよいと答えた割合が多かったのは、1000 人以上の企業が 57.1%、ついで 300 人～999 人の企業が 41.7%であった。一方で、フルタイム勤務が原則の企業は、多いものから順位 100 人未満が 40.0%、1000 人以上の企業が 28.6%であった。社員数が多い企業ほど復職の際にフルタイムでなくてよいと答えた割合が多く、復職はフルタイムが原則の企業は 100 人未満の企業の割合が高かった。（100 人未満:n=10、100~299 人:n=8、300~999 人:n=12、1000 人以上:n=14 であった）

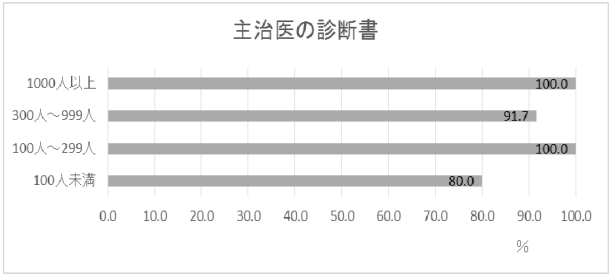


（図 14：企業規模と復職時の勤務形態）

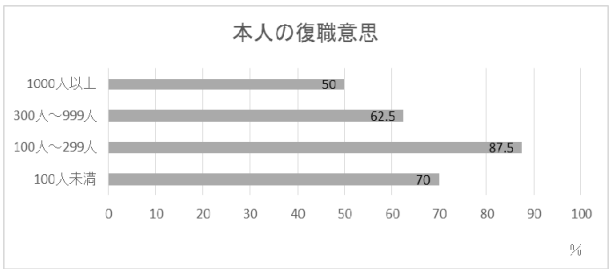
Q7 復職の手続き上の必須条件は何ですか、について（図 15～図 18）

社内制度で規定されている復職の手続き上の必須条件は、1000 人以上と 100~299 人の企業の 100%が「主治医の診断書」を必須としていたが、「主治医の診断書」は企業の社員数に関わらず、必須条件に挙げている企業が多かった。「本人の復職意思」は 100~299 人が 87.5%と高く、「会社の許可」と「産業医」の意見を必須条件としている企業は 1000 人以上の企業の割合が高かった。しかし、「産業医」の意見を必須条件としている企業は 100 人未満の企業で少なかった。

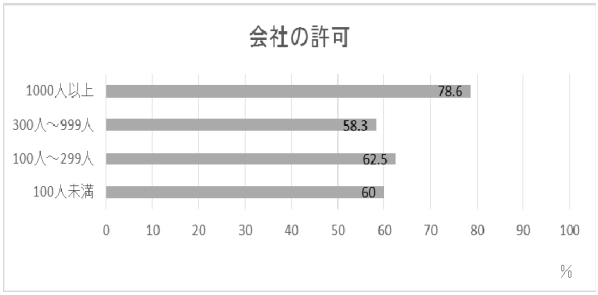
（100 人未満:n=10、100~299 人:n=8、300~999 人:n=12、1000 人以上:n=14 であった）



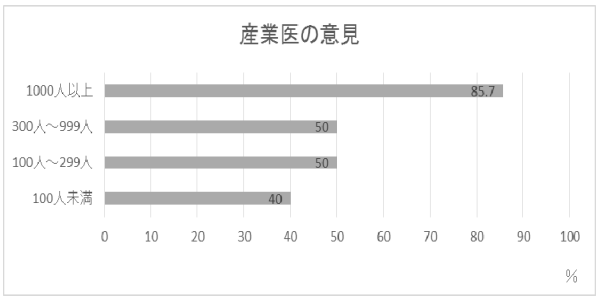
（図 15 ：企業規模と復職手続き上の必須条件「主治医の診断書」）



（図 16：企業規模と復職手続き上の必須条件「本人の復職意思」）



（図 17：企業規模と復職手続き上の必須条件「会社の許可」）



（図 18：企業規模と復職手続き上の必須条件「産業医の意見」）

（9） 病気の治療と職業生活の両立支援に関する企業の意見

・勤務形態・両立支援についての制度の整備、周囲の理解等職場環境、明確な対応策についての意見を認めた。

企業１：身体に障害が残っている場合は、安全配慮義務の観点等から、当社では復職は難しいと思われる。

企業２：当社では、高齢の嘱託の方が脳卒中で療養した事例があります。療養半年後に期間満了による退職になりましたが、当初の退職予定日をもって労使双方合意の上、退職した。病気になってから退職まで約半年の期間があったが積立休暇制度を使い給与・賞与は全額支給して対応した。

企業３：ある社員が、かなり以前に脳卒中に罹患したが、今でも就労を継続している。本人の病状に周囲の理解も必要でしょうが、健常社員との折り合いの整合性の取り方が難しい部分もあると思う。

企業４：社員に後遺症が無く、復職までの期間も比較的短い方だったので、対応は出来ましたが、今後、後遺症が残ってしまった場合はどのような対応が出来るのか不明だと考える。労災で且つ復職の見込みがたたない場合は、どのような対応が出来るのか不明です。

企業５：現在１名が脳卒中で休職中である。症状固定の判断が難しいため、復職の判断が難しいように思われる。

企業６：毎年の健康診断で、高脂質者が低年齢化していると、産業医から指摘されました。職種的に深夜の食事をとる社員が多く、それが理由だと思っています。本人達に注意を促し 2 次検査に行くように案内するのですが、「自分は大丈夫」と思っている社員が多いのか、全く響いていません。本人達にどうやったら自覚を持ってもらえるのか、重要性を理解してもらうにはどうしたら良いのか悩み所です。

企業７：普段の健康管理が重要だと思います。組織としてケアしていける環境が出来あがると良いかと思います。

企業８：相当以前になるが、営業管理職で単身赴任中のアパートにて発症し、対応が遅れたこともあり、片麻痺による運動機能の低下、言語障害、軽度の認知障害が残ってしまった。リハビリを行いながら軽度の事務作業として復帰したが、改善が見られず退職に至った。1 名しか経験ないが、重度の場合は業務遂行能力の問題から復帰は厳しいと考える。

企業９：少子高齢化も進み、社員の家族を含め、

課題として取り組まなければならない問題ですが、中小企業としては、人の問題や職場環境等改善が必要です。働き方改革を推進する一方で、現実的に厳しいです。
企業１０：メンタルヘルスの職場復帰支援の様に手引きや指針が出ると企業としては取り組みやすいと考えます。製造業は、仕事の内容が融通がきかず、デスクワークも限られているため、その方に合った業務に移行させてあげることが難しいケースがあります。通院や治療で休みを必要とするケースも多く、勤務日数の削減制度や期限を問わない短時間勤務制度などの導入が必要だと思います。
企業１１：昔と違い、社会復帰できる病気なだけに、ご本人がどういう支援を望むのか（勤務時間と通院の兼ね合いなど）にできる限り応えたいと考えるが、一人一人の”ケースバイケース”になってしまうと対応するにも限界があるため、ある程度のメニュー化（パターン化）ができるのであれば、対応する総務側としてもイメージがわきやすいと思います。
企業１２：柔軟な働き方ができる環境整備と保健師・産業医等の専門家と主治医も含めた連携が不可欠だと思います。
企業１３：優秀な人材流出を防ぐ福利厚生面として重大な課題であると認識している。国の支援も必要であると考える。
企業１４：両立支援は該当者本人のためには当然守ってあげたい権利かもしれませんが、その他大勢の健常社員の理解や会社としてどこまで支援できるかは、病気により個々のケースが想定され、一律の制度運用では難しい点が多いと思います。
企業１５：4 年半の Long term disability 保険を活用して頂くようにしている。１人の仕事量が多く、ゆとりが元々ない会社なので、両立するのは大変そうです。他国では多くの人が両立しています。
企業１６：健康診断による早期発見、発症後は休職、時間有給取得等の制度、就業上の配慮や産業医への相談窓口設置による支援を行うことはできるが、後遺症等により著しく業務遂行能力が落ちる場合は、提供する業務がなく、両立支援にも限界がある。状態による実行可能な具体的ガイドラインが必要。
企業 17: 後遺症により何らかの障害が残った場合に、どの様な業務担当として復職して貰うかが課題の一つと考えます。

Ｅ．結論

脳卒中に罹患した社員の 80%が復職し、そのうちの 82%が再病休せずに働いていることが示された。社員数が 100 人未満の企業は、1000 人以上の企業に比べて、復職に際してフルタイム勤務が原則である割合が高いことが認められた。復職支援制度として短時間勤務制度は、現在導入している制度においても、今後導入可能性のある制度においても割合が高く、在宅勤務制度や退職者の再雇用制度の割合が低かった。正社員と非正規社員の間で、両立支援における制度の格差を認めた。

Ｇ．研究発表

1. 論文発表
   今後、論文発表を予定している。
2. 学会発表
   今後、学会発表を予定している。

Ｈ．知的財産権の出願・登録状況（予定を含む。）

特になし

労災疾病臨床研究事業費補助金

平成 29 年度分担研究報告書

「がん患者の治療と就労の両立」に関する調査

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研究要旨

近年、がんに罹患した労働者が急増することが見込まれ、がん患者の治療と就労の両立支援は、国における最重要課題として位置づけられている。今回、中小企業の労働者が、がんを患っても、安心して治療を受けつつ就労と両立できる仕組みを構築することを主目的に調査を行った。近畿圏において中小企業の基準にあたる従業員数の事業場100社を対象にアンケートの調査協力依頼を行い、報告日までに40社の回答を得た。

治療中に働き方や給付制度に関する案内の支援は 10 事業場（25.6%）があると回答し、柔軟な勤務時間は 33 事業場（82.5%）、人事制度運用は 20 事業場（52.6%）、両立支援への理解は 29 事業場（76.3%）、主治医などとの連携は 23 事業場（60.5%）があると回答している。

家族のがんに対して臨機応変に働き方を変更できる取り組みがあるかどうかに関しても 23 事業場（57.5%）があると回答しており、社員のライフ・ワーク・バランスに関しては一定の理解があるといえる。

また、実際にがん社員の経験の有無を聞くと、25 事業場（64・1%）で経験があると回答があり、そのうち、がん社員の復職経験のある事業所が 20 事業場（76.9%）あった。復職で困った経験があると答えた事業所が３事業場（10.3%）あり、がん両立支援職場の必要性を強く感じている 17 事業場（42.5%）、どちらかというと感じている 18 事業場（45%）と全体の 87.5%が必要性を感じていると回答した。

がんの両立支援を推進する職場を進める上での課題としては、人員確保が 26 事業場（65%）の事業場からあがり、続いて、保健師など事業所内スタッフによるケアの欠如、不安感への対応、具体的な支援方法などが上位を占めた。

中小企業の社員の方が、がんを患っても、安心して治療を受けつつ就労と両立できる仕組みを構築するためには、多くの事業場で求められている人員確保などの支援策は早急な対応は困難である。しかし、保健師など事業所内スタッフによるケアを行政の助成により推進することができれば、合わせて、がん患者の不安感への対応や具体的な支援方法の提案などで、その他の問題も柔軟に対応できる可能性がある。

本調査は回収した企業が労働衛生機関の顧客企業であり、50～299 人の情報は得られたものの、50 人未満規模の事業場は 20%と少なかったため、小規模事業場の状況は十分に把握できているとは言えない。今後さらに情報収集することが望ましい。

平成 29 年度厚生労働省の研究事業「企業・産業保健スタッフ・医療機関の連携による両立支援（がん患者の治療と就労の両立）システムの開発」プロジェクト研究の一部として実施した。平成 30 年度も引き続き中小企業を中心に調査研究を継続していく予定である。

A. 研究目的

A. 目的

がんはかつてのように不治の病ではなく、緩解を維持しながら日常生活を送ることのできる慢性疾患に変化している。しかし、実際には治療と職業生活の両立が困難となり離職を余儀なくされる事例は少なくない。中小企業は一般に人的資源、金銭的資源が大企業に比べて乏しく、がん患者の就労支援についても差があると考えられるが、これまでのがんの治療と就労の両立支援についての研究では、常勤の産業看護職や看護職のいる事業場を対象とするもの、専属産業医の割合が高い大企業を中心とするものなどが多い[1) 2) 3)]。そのため、中小企業におけるがん患者の就労支援ついての実態を把握し、労働者ががんを患っても安心して治療を受けつつ就労と両立できる仕組みを構築するために、労働者の健康への配慮と労働者ががんになった際の取り組み等に関するアンケート（以下、アンケート）調査を行った。

B. 研究方法

調査：質問紙調査

近畿圏において中小企業の基準にあたる従業員数の事業場100社を対象にアンケートの調査協力依頼を行った。調査票の発送および回収は手渡しと郵送法を併用した。報告日までに40社の回答を得た。

アンケート内容は次のとおりである.

①会社概要に関する質問（業種・社員数・非正規社員及び女性社員の割合・社員の平均年齢・産業医及び産業看護職の選任）

②会社の社風に関する質問（６問）

③会社の健康管理に関する質問（６問）

④会社の健康づくり活動全般の質問（8問）

⑤がん治療と治療の両立支援のための支援策についての質問（10問）

倫理面への配慮

調査は東京大学倫理審査委員会の承諾を得て行った．質問紙調査はすべて無記名で実施し，回答をもって調査へ同意を得たと判断した。

C. 研究結果

調査

アンケート配布 1 ヶ月後の中間報告として、40 事業場から協力が得られた（回収率：40%）。アンケート結果は表 1 に示す。

企業規模は 50 人未満：8 事業場（20%）、50～99 人：9 事業場（22.5%）、100～299 人：17 事業場（42.5%）、300～999 人：4 事業場（10%）、1000 人以上：2 事業場（5%）であった。業種は、製造業 15 事業場（38.5%）、卸売業・小売業 6 事業場（15.4%）、建設業 3 事業場（7.7%）、その他 7 事業場（17.5%）であった。

産業医の選任については、選任している（常勤）が 3 事業場（7.7%）、選任している（嘱託）が 26 事業場（66.7%）、選任していないが 10 事業場であった。

① 会社概要に関する質問

事業所の業種で最も多かったのが「製造業」の 15 事業場（38.5%）であり、次いで「卸売業・小売業」が 6 事業場（15.4%）、「建設業」が 3 事業場（7.7%）、と続いた.

事業所の構成については、従業員数が「50 人未満」が 8 事業場（20%）、「50 人～99 人」が 9 事業場（22.5%）、「100～299 人」が 17 事業場（42.5%）、「300 人以上」が 6 事業場

（15%）であり、100～299 人の事業場が最も多かった. 非正規社員割合は、「50%未満」が 29 事業所（72.5%）、「50%以上」が 5 事業所（12.5%）、「80%以上」が 6 事業所（15%）であった。従業員の女性割合は、「50%未満」が 31 事業所（77.5%）、「50%以上」が 6 事業所（15%）、「80%以上」が 2 事業所（5%）、「100%」が 1 事業所（2.5%）であり、従業員の平均年齢は「40 代」が 29 事業所（74.4%）と最も多く、次いで「30 代」が 5 事業所（12.8%）、「50 代」が 4 事業所（10.3%）の順であった。74.4%の事業所で産業医を選任しており、22.5%の事業所で産業看護職を選任していた。

②会社の社風に関する質問

社風に関する各質問における肯定的な意見（まあそうだ・そうだ）が占める事業所割合は「ともに働こうという姿勢」に関して 34 事業所（86.8%）、「お互いに理解している」に関して 30 事業所（78.9%）、「情報共有」に関して 28 事業所（73.7%）、「助け合いの雰囲気」に関して 28 事業所（73.7%）、「お互いに信頼」に関して 23 事業所（60.5%）、「笑いがある職場」に関して 33 事業所（81.6%）であった。

② 会社の健康管理に関する質問

「経営理念に健康、幸せ」の有無に関しては 19 事業所（47.5%）、「就業規則などでの個人情報の取り扱い」の有無に関しては 31 事業所（79.5%）が有りと回答した。「健康診断受診率」は全ての事業所で 80%以上であり、受診率 100%の事業所割合も 30 事業所（75%）を占めた。「再検査の受診勧奨」の有無に関しては 37 事業所（92.5%）、「産業保健専門職による日々の健康管理への関わり」の有無に関して 21 事業所（52.5%）の事業所が有りと回答し、その際の健康管理の主担当は医師が 60%、産業看護職が 25%を占めた。

④会社の健康づくり活動全般の質問

「がん検診オプション」の有無に関して 21 事業所（52.5%）、「食生活の改善の取り組み」の有無に関して 11 事業所（27.5%）、「運動の取り組み」の有無に関して 14 事業所（35%）、「禁煙／受動喫煙の取り組み」の有無に関して 21 事業所（57.5%）、「メンタルヘルスの取り組み」の有無に関しては 29 事業所（72.5%）と健康づくり活動において一番高い割合を占めた。また、「睡眠の取り組み」、「腰痛の取り組み」、「肩こりの取り組み」の有無に関しては、7 事業所（17.5%）、10 事業所（25%）、8 事業所（20%）と「運動の取り組み」や「食生活改善の取り組み」同様、生活習慣改善の取り組みを導入している事業所割合は低かった。

⑤がん治療と治療の両立支援のための支援策についての質問

「治療中に働き方や給付制度の案内の支援」は 34 事業所（85%）、「社員教育・啓発」は 7 事業所（18%）、「相談できる担当者」は 37 事業所（92.5%）、「相談窓口」は 29 事業所（74.4%）、「治療を続けながら仕事を継続できる就業規則」は 10 事業所（25.6%）があると回答した。

また具体的な両立支援策として、「柔軟な勤務時間」33 事業所（82.5%）、「人事制度の柔軟な運用」20 事業所（52.6%）、「両立支援への理解」29 事業所（76.3%）、「主治医などと連携」23 事業所（60.5%）があると回答している。

「家族のがんで臨機応変に対応するか」に関しても 23 事業所（57.5%）があると回答しており、社員のライフ・ワーク・バランスに関しては一定の理解があるといえる。
また、実際に「がん社員の経験の有無」を聞くと、25 事業場（64・1%）で経験があると回答があり、そのうち、がん社員の復職経験のある事業場が 20 事業場（76.9%）あった。「復職で困った経験」があるとこたえた事業所が３事業場（10.3%）あり、「がん両立支援職場の必要性」を強く感じているのは 17 事業場（42.5%）、どちらかというと感じているのは 18 事業場（45%）と全体の 87.5%が必要性を感じていると回答した。
がんの両立支援を推進する職場を進める上での課題としては、代替要員の確保が６５％の事業場があげ、続いて、保健師など事業所内スタッフによるケア、不安感への対応、具体的な支援方法などが上位を占めた。

D. 考察

本調査に協力のあった事業場では、従業員数 50 人未満の事業場が 40 事業場中８事業場（20%）、300 人未満の従業員数の事業場が 40 事業場中 34 事業場を占めている（85%）。一方、平成 26 年「経済センサス基礎調査」[4]によれば、全国の民営事業所 554 万 1,634 事業所のうち、従業員 50 人未満規模の小規模事業所が全事業所数の 96.7%、従業員 300 人未満規模のいわゆる中小企業は全事業所数の 99.4%を占めている。本調査ではやや調査企業数が少ないため、小規模事業所に関しての一般化は難しい面があるが、概ね京都府の中小企業の実態を表しているといえる。

本調査におけるがん治療と就労の両立支援のための支援策について、「社員教育・啓発」は 18%と実施できている事業場は多くはないが、少しの努力でできると答えた事業場も 61.3%と少なくないため、「社員教育・啓発」は優先的に取り組むべき支援策と言える。
一方、「「治療を続けながら仕事を継続できる就業規則」」は 25.6%と体制整備できている事業場が少なく、支援策導入が難しいと考える事業場も多いため、「社員教育・啓発」ほど容易ではなく、社労士など専門家と連携を検討した中小企業が両立支援を導入しやすい就業規則の様式作成などが必要と考える。

また、立石らの研究[5]では、大企業における働くがん患者への就業支援として、代表的なものとして、“社内における復職支援制度” “不安やうつなどのメンタルヘルスの対応” “主治医との情報共有” “職場の理解”などをあげている。具体的には“社内における復職支援制度”の中には、安心して休める制度（休職規定や傷病手当金など）の情報提供、ためし出勤・リハビリ勤務、復職後の通院などのための休暇・短時間勤務制度などがあがっていた。本調査における「治療を続けながら仕事を継続できる就業規則」の具体的な両立支援策として、「柔軟な勤務時間」33 事業場（82.5%）、「人事制度の柔軟な運用」20 事業場（52.6%）、「両立支援への理解」29 事業場（76.3%）、「主治医などと連携」23 事業場（60.5%）がすでに実行していることとしてあがっており、中小企業でも大企業同様に両立支援策は推進しつつあることが推察される。し

かし、この中でやや定率である「人事制度の柔軟な運用」はマンパワーが大企業と比較すると厳しい現状があるため、これからの課題と言える。「主治医などとの連携」については、中小企業においては大企業より産業医や産業保健職が活動する頻度が少ないため、上手に運用できている企業は多数ではない。事業場における治療と職業生活の両立支援のためのガイドライン[6]にも主治医との連携を円滑にする様式が紹介されているが、今ある両立支援ツールの活用方法を産業医などが事業場に紹介し、様式を円滑に導入し、主治医などとの有効な連携を実現することが肝要と考える。

さらに、がん療養となった社員の転帰に関して言及すると、2013 年のがん体験者の悩みや負担などに関する実態調査[7]では、がん患者となった勤務者の 34%が依願退職、解雇されているという報告がある。森口の研究では、メンタルヘルス不調での休職者の割合は企業規模が小さくなるほど少なく[8]、休職することも難しくなる状況が推察される。本調査では、がんで療養となった社員がいる事業場は 25 事業場（64.1%）を占め、そのうち、対象の方が復職したと答えた事業場が 76.9%、復職しなかった 7.7%、どちらもいる 15.4%という結果であった。こうした高い復職率は、労働衛生機関の顧客企業のため、産業保健レベルが一般的な中小企業より高い可能性が考えられる。

2015 年の高橋らによる離職のタイミングに関する多施設調査[9]においても、離職者の 40.2%ががんの治療開始前に離職しているとの報告があることからも、がん患者においてもメンタルヘルス不調同様に、企業規模が小さくなるほど休職が難しく、離職に繋がりやすい状況が想定される。

がん治療と就労の両立支援が実現できる職場づくりの課題として、代表的なものとして、代替要員の人員の確保（65%）、保健師など事業所内スタッフによるケア（35%）、不安感への対応（33%）、具体的な支援方法（33%）などがあがっている。代替要員の人員の確保は中小企業において非常に難しい課題ではあるが、人員の確保に向けて、行政の補助などが望まれる。2018 年度の診療報酬改定答申にがん治療と仕事の両立を目指し、がん治療と仕事の両立を診療報酬で評価すると記載された。[10] このような取り組みが広がり、人員確保にも寄与することが期待される。また、保健師などの事業所内スタッフによるケアが高いニーズがある。両立支援を推進するにあたっては小規模事業場の産業医選任助成のような、保健師選任助成も対策として選択肢の一つとして考えられる。事業場での保健師選任が進めば、その他の課題である、不安感への対応や具体的な支援方法にも柔軟に対応できる可能性がある。

本調査の限界は回収率が 40%程度（配布後 1 ヵ月後）であり、調査に前向きな企業に偏った可能性があげられる。　回収した企業が労働衛生機関の顧客企業のため、産業医の選任義務のない 50 人未満規模の事業場は 20%と少ないことから、小規模事業場の状況は十分に把握できているとはいえない。また、回答のなかった事業場の実情は回答のあった事業場よりも厳しい可能性が考えられる。この点は今後の検討課題である。

E. 研究発表

1. 論文発表なし
2. 学会発表なし

F. 知的財産権の出願・登録状況（予定を含む）

1. 特許取得なし
2. 実用新案登録なし
3. その他なし

G. 参考文献

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3. 働くがん患者と家族に向けた包括的就業支援システムの構築に関する研究
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   研究代表者　高橋　都
4. 14. 経済センサス基礎調査
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9. 離職のタイミング多施設調査
   2015 年　厚生労働省科研高橋班
10. 平成 30 年度診療報酬改定答申
    厚生労働省

表　質問紙調査の結果

質問項目	**n**	**(%)**
主な業種（単一回答） (n=39)	39	(100)
建設業	3	(7.7)
製造業	15	(38.5)
電気・ガス・熱供給・水道業	1	(2.6)
情報通信業	1	(2.6)
運輸・郵便業	2	(5.1)
卸売業、小売業	6	(15.4)
金融業、保険業	2	(5.1)

不動産業	0	(0.0)
飲食業	0	(0.0)
教育、学習支援業	0	(0.0)
医療・福祉	0	(0.0)
その他	9	(23.1)
その他（n=9)の記述あり（n=7）	7	(100)
サービス業	2	(si28.6)
ビルメンテナンス業	1	(14.3)
警備業	1	(14.3)
産廃処理業	1	(14.3)
神道系宗教	1	(14.3)
整備業	1	(14.3)
全体の社員数（単一回答）（パート、契約社員、派遣社員等含む） (n=40)	40	(100)
1～9 人	0	(0.0)
10～19 人	1	(2.5)
20～49 人	7	(17.5)
50～99 人	9	(22.5)
100～199 人	12	(30.0)
200～299 人	5	(12.5)
300～499 人	3	(7.5)
500～999 人	1	(2.5)
1000 人～2999 人	1	(2.5)
3000 人以上	1	(2.5)
非正規社員割合 (n=40)	40	(100)
把握していない	0	(0.0)
50%未満	29	(72.5)
50%以上	5	(12.5)
80%以上	6	(15.0)
女性社員割合 (n=40)	40	(100)
把握していない	0	(0.0)
50%未満	31	(77.5)
50%以上	6	(15.0)
80%以上	2	(5.0)
100%	1	(2.5)
社員の平均年齢（単一回答） (n=39)	39	(100)
10 代	0	(0.0)
20 代	0	(0.0)
30 代	5	(12.8)
40 代	29	(74.4)

50 代	4	(10.3)
60 代	1	(2.6)
70 代	0	(0.0)
産業医（単一回答） (n=39)	39	(100)
選任している（常勤）	3	(7.7)
選任している（非常勤または嘱託）	26	(66.7)
選任していない	10	(25.6)
産業看護職（単一回答） (n=40)	40	(100)
選任している（常勤）	5	(12.5)
選任している（非常勤または嘱託）	4	(10.0)
選任していない	31	(77.5)
社風		
私たちの職場では、ともに働こうという姿勢がある (n=38)	38	(100)
違う	2	(5.3)
やや違う	3	(7.9)
まあそうだ	26	(68.4)
そうだ	7	(18.4)
私たちの職場では、お互いに理解し認め合っている (n=38)	38	(100)
違う	2	(5.3)
やや違う	6	(15.8)
まあそうだ	26	(68.4)
そうだ	4	(10.5)
私たちの職場では、仕事に関連した情報の共有ができている(n=38)	38	(100)
違う	1	(2.6)
やや違う	9	(23.7)
まあそうだ	22	(57.9)
そうだ	6	(15.8)
私たちの職場では、助け合おうという雰囲気がある (n=38)	38	(100)
違う	0	(0.0)
やや違う	10	(26.3)
まあそうだ	22	(57.9)
そうだ	6	(15.8)
私たちの職場では、お互いに信頼し合っている (n=38)	38	(100)
違う	1	(2.6)
やや違う	14	(36.8)
まあそうだ	20	(52.6)
そうだ	3	(7.9)
笑いや笑顔がある職場だ(n=38)	38	(100)

違う	0	(0.0)
やや違う	7	(18.4)
まあそうだ	25	(65.8)
そうだ	6	(15.8)
現状		
社是や経営理念に、社員の「健康」や「幸せ」が含まれていますか (n=40)	40	(100)
はい	19	(47.5)
いいえ	21	(52.5)
「いいえ」⇒導入または改善することはできますか？	20	(100)
少し努力すれば	9	(45.0)
かなり努力すれば	8	(40.0)
出来そうもない	3	(15.0)
就業規則等において個人の健康情報の取扱いを定め運用(n=39)	39	(100)
はい	31	(79.5)
いいえ	8	(20.5)
「いいえ」⇒導入または改善することはできますか？	8	(100)
少し努力すれば	5	(62.5)
かなり努力すれば	2	(25.0)
出来そうもない	1	(12.5)
健康診断受診率は何％ですか？(非正規社員は含みません) (n=40)	40	(100)
把握していない	0	(0.0)
60%未満	0	(0.0)
60%以上	0	(0.0)
80%以上	1	(2.5)
90%以上	9	(22.5)
100%	30	(75.0)
（100%未満の場合）導入または改善することはできますか？	7	(100)
少し努力すれば	4	(57.1)
かなり努力すれば	2	(28.6)
出来そうもない	1	(14.3)
再検査が必要である社員に、病院への受診を勧めていますか(n=40)	40	(100)
はい	37	(92.5)
いいえ	3	(7.5)
「いいえ」⇒導入または改善することはできますか？	4	(100)
少し努力すれば	2	(50.0)
かなり努力すれば	2	(50.0)
出来そうもない	0	(0.0)
産業医や保健師が、日々の健康管理にかかわっていますか(n=40)	40	(100)

はい	21	(52.5)
いいえ	19	(47.5)
「いいえ」⇒導入または改善することはできますか？	19	(100)
少し努力すれば	4	(21.1)
かなり努力すれば	9	(47.4)
出来そうもない	6	(31.6)
設問 17 に「はい」の場合、健康管理の主担当(n=20)	20	(100)
医師	12	(60.0)
医師・保健師・看護師	1	(5.0)
保健師	4	(20.0)
看護師	1	(5.0)
その他	2	(10.0)
その他	2	(100)
医師、保健師と会社が協力	1	(50.0)
産業医	1	(50.0)
健康づくり活動		
貴社では社員の健康への取り組みとしてがん検診オプションがありますか（自己負担や自治体のがん検診受診費用負担は除く） (n=40)	40	(100)
はい	21	(52.5)
いいえ	19	(47.5)
「いいえ」⇒導入または改善することはできますか？	16	(100)
少し努力すれば	4	(22.2)
かなり努力すれば	8	(44.4)
出来そうもない	6	(33.3)
貴社では「食生活の改善」に関する取り組みを行っていますか (n=40)	40	(100)
はい	11	(27.5)
いいえ	29	(72.5)
「いいえ」⇒導入または改善することはできますか？	27	(100)
少し努力すれば	11	(40.7)
かなり努力すれば	12	(44.4)
出来そうもない	4	(14.8)
貴社では「運動」に関する取り組みを行っていますか (n=40)	40	(100)
はい	14	(35.0)
いいえ	26	(65.0)
「いいえ」⇒導入または改善することはできますか？	24	(100)
少し努力すれば	9	(37.5)
かなり努力すれば	10	(41.7)
出来そうもない	5	(20.8)

貴社では「禁煙／受動喫煙」に関する取り組みを行っていますか (n=40)	40	(100)
はい	23	(57.5)
いいえ	17	(42.5)
「いいえ」⇒導入または改善することはできますか？	16	(100)
少し努力すれば	7	(43.8)
かなり努力すれば	5	(31.3)
出来そうもない	4	(25.0)
貴社では「メンタルヘルス」に関する取り組みを行っていますか (n=40)	40	(100)
はい	29	(72.5)
いいえ	11	(27.5)
「いいえ」⇒導入または改善することはできますか？	10	(100)
少し努力すれば	2	(20.0)
かなり努力すれば	5	(50.0)
出来そうもない	3	(30.0)
貴社では「睡眠」に関する取り組みを行っていますか (n=40)	40	(100)
はい	7	(17.5)
いいえ	33	(82.5)
「いいえ」⇒導入または改善することはできますか？	31	(100)
少し努力すれば	12	(38.7)
かなり努力すれば	12	(38.7)
出来そうもない	7	(22.6)
貴社では「腰痛」に関する取り組みを行っていますか (n=40)	40	(100)
はい	10	(25.0)
いいえ	30	(75.0)
「いいえ」⇒導入または改善することはできますか？	28	(100)
少し努力すれば	12	(42.9)
かなり努力すれば	9	(32.1)
出来そうもない	7	(25.0)
貴社では「肩こり」に関する取り組みを行っていますか (n=40)	40	(100)
はい	8	(20.0)
いいえ	32	(80.0)
「いいえ」⇒導入または改善することはできますか？	30	(100)
少し努力すれば	12	(40.0)
かなり努力すれば	11	(36.7)
出来そうもない	7	(23.3)
がん治療と就労の両立支援のための支援策		
社員の病気に対して働き方や給付制度の案内をするなどの支援 (n=40)	40	(100)
はい	34	(85.0)

いいえ	6	(15.0)
導入または改善することはできますか？	6	(100)
少し努力すれば	3	(50.0)
かなり努力すれば	2	(33.3)
出来そうもない	1	(16.7)
治療を続けながら仕事を継続する支援の方法について社員に教育や啓発を行っていますか (n=39)	39	(100)
はい	7	(18.0)
いいえ	32	(82.1)
導入または改善することはできますか？	31	(100)
少し努力すれば	19	(61.3)
かなり努力すれば	11	(35.5)
出来そうもない	1	(3.2)
病気を理由に休暇や休業をとる際、社員が相談できる担当者がいますか (n=40)	40	(100)
はい	37	(92.5)
いいえ	3	(7.5)
導入または改善することはできますか？	3	(100)
少し努力すれば	0	(0.0)
かなり努力すれば	2	(66.7)
出来そうもない	1	(33.3)
病気になっても無理なく働けるよう、社員が相談できる窓口がありますか (n=39)	39	(100)
はい	29	(74.4)
いいえ	10	(25.6)
導入または改善することはできますか？	10	(100)
少し努力すれば	4	(40.0)
かなり努力すれば	3	(30.0)
出来そうもない	3	(30.0)
治療を続けながら仕事を継続する社員を受け入れる仕組みを、就業規則等で定めていますか (n=39)	39	(100)
はい	10	(25.6)
いいえ	29	(74.4)
導入または改善することはできますか？	29	(100)
少し努力すれば	9	(31.0)
かなり努力すれば	17	(58.6)
出来そうもない	3	(10.3)
両立支援の際、勤務時間や勤務形態に対する柔軟な対応が可能ですか（フレックスタイムや時差出勤、短時間勤務など） (n=40)	40	(100)

はい	33	(82.5)
いいえ	7	(17.5)
導入または改善することはできますか？	7	(100)
少し努力すれば	0	(0.0)
かなり努力すれば	1	(14.3)
出来そうもない	6	(85.7)
両立支援の際に、人事制度を柔軟に運用していますか (n=38)	38	(100)
はい	20	(52.6)
いいえ	18	(47.4)
導入または改善することはできますか？	18	(100)
少し努力すれば	9	(50.0)
かなり努力すれば	4	(22.2)
出来そうもない	5	(27.8)
職場は両立支援に理解がありますか (n=38)	38	(100)
はい	29	(76.3)
いいえ	9	(23.7)
導入または改善することはできますか？	9	(100)
少し努力すれば	2	(22.2)
かなり努力すれば	3	(33.3)
出来そうもない	4	(44.4)
主治医や上司、人事などの連携が行われていますか (n=38)	38	(100)
はい	23	(60.5)
いいえ	15	(39.5)
導入または改善することはできますか？	15	(100)
少し努力すれば	5	(33.3)
かなり努力すれば	8	(53.3)
出来そうもない	2	(13.3)
社員の家族が、がんを患った場合、臨機応変に働き方を変更する取り組み(労働時間や給与体系も含む)をされていますか (n=40)	40	(100)
はい	23	(57.5)
いいえ	17	(42.5)
導入または改善することはできますか？	17	(100)
少し努力すれば	7	(41.2)
かなり努力すれば	7	(41.2)
出来そうもない	3	(17.7)
がんのために療養となった社員がいますか (n=39)	39	(100)
はい	25	(64.1)
いいえ	14	(35.9)

「はい」の場合、対象の方は復職されましたか？	26	(100)
復職した	20	(76.9)
どちらもいる	4	(15.4)
復職しなかった	2	(7.7)
復職において企業のお立場で困った経験はありますか (n=29)	29	(100)
はい	3	(10.3)
いいえ	26	(89.7)
はいとお答えの方は差し支えない範囲で、その経験談・ご意見		
主治医との連携　・本人からの情報が少ない　・診断書の提出を嫌がる（特に女性疾患）		
製造ラインに入っている者が通院で抜けると、ラインごと生産計画を立て直すなど先読みできないところが困った。		
通院と業務のバランスを上司と相談し入院にも備える準備がうまくできており治療に専念できた為無理なく職場復帰できた		
分かりませんが、社員への配慮が足りていたとは思いにくい。		
本人は復職を希望するが、担当させる業務がない。また受入れ部所がない。各部所には負担となると考える人もいる。		
がんの治療と就労の両立が実現できる職場づくりへの必要性について (単一回答) (n=40)	40	(100)
必要性を強く感じている	17	(42.5)
どちらかというと必要性は感じている	18	(45.0)
あまり必要性は感じていない	5	(12.5)
必要性は全く感じていない	0	(0.0)
今までに貴事業所でがん社員を対応した経験から、もしくは、今後がん社員の発生等、予想される事態を想定して)、治療と就労の両立が実現できる職場づくりを進める上での課題と思われるもの（複数回答可）		
社員ががんになった時に、どこに相談したらよいか分からない	5	12.5
長時間働けない社員の社会保険料の事業主負担が大きい	11	27.5
主治医から、明確な対応策に関する情報が得られない	9	22.5
産業医等から、明確な対応策に関する情報が得られない	2	5
保健師、看護師とのコミュニケーションが乏しい	3	7.5
社員の健康支援を行う保健師や看護師がいない	14	35
代替要員の確保が困難、業務分担への配慮	26	65
会社精度（休暇・休職制度、就業時間等）との不整合	9	22.5
周りの社員の理解不足	7	17.5
具体的な支援の方法がよく分からない	13	32.5
病気そのものや治療の内容がよく分からない	12	30
本人の不安感への対応などをどうしたらよいかわからない	13	32.5
治療や生活のための金銭的なサポートを行う財源がない	5	12.5
その他	0	0

今までに、社員ががんになった経験をお持ちの方は、差し支えない範囲で、その経験談・御意見を教えて頂けますと大変ありがたいです（自由記載）		
1 名しか前例がありませんが、本人の意欲と体力の回復にアンバランスさがあり、まわりが心配する事態となった。通勤途中に事故などないか、など。		
61 才　乳がん　女性入院、手術後、予定通り復職したが、体調不良や通院で欠勤がちになり、年齢のこともあり、本人から退職を申し出た。		
時代とともに就労両立支援は充実してきているが、「がん」はまだまだタブー視されていて従業員（患者）は隠しておきたい意識が強いように思う。受け入れ側も「がん」は特別なもののようになっているのでは？「治療と就労」を世の中に広く周知していただきたい。		
治療を最優先にして頂き周囲が理解して助け合う事ができる環境である事を本人にも伝え安心して働いて頂けるよう管理職から話をしてもらってます。		
少しずつ就労時間を短くし、本人の意思で仕事を続けておられましたが残念乍ら亡くなりました。		
詳しい医療知識を持ち合わせてはいないが、やはり若い人（60 才未満の人）だとがんの進行が早いのか、復職できなかったケースが多い。」（俗説？）死亡退職の手続きを行うことは悲しい感情だけではなく、切ない、虚しいといった気持ちになるので、あまり味わいたくない。そういった面からも復職できることが望ましいと思う。		
人事担当者としてこれまでに 4 名ほどがんになった従業員の対応をしてきましたが、全員がそれを理由に退社されることなく、一定の療養期間ののち職場復帰されてうち 2 名は現在も元気に就労されています。そのつど自社雇用の看護師や産業医、主治医とやり取りすることで比較的スムーズに復職、就労支援ができたように感じます。産業保健スタッフ（看護師と産業医）にすぐに相談できるという体制があり、心強いです。		
正社員は療養のかいなく亡くなるものが多く、免許資格所得者が亡くなった時は特に大変でした。(他にわかるものもおりませんし、免許を取得するのにお金もパートの方はほとんど退職されてしまいます。		
早期の胃がんが見つかり、切除手術の後、職場へ復帰し、今は元気に働いている（約 10 年前手術）		
本人が仕事に対して体力的に無理をしているのかどうかがわからない。		
本人より状態と開ける時は対応しやすいがそれが無理な時は会社としてもどうしていいのかわからない。		

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治療と職業生活の両立支援における産業保健師の機能と役割

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研究要旨

平成 28 年 2 月に厚生労働省から「事業場における治療と就業生活の両立支援のためのガイドライン」が公表されたことを受け、治療と就業生活の両立支援における産業看護職である産業保健師の役割を検討した。産業保健師による治療と就労の両立支援では**【会社全体の仕組みづくり】【柔軟な人事制度】**への働きかけをおこない、上司や職場の理解を促しながら**【職場の協力を得る】**こと、医療的な判断力や連携・調整力を発揮させ、対象者自身を支える**【対象者への看護的支援】**をおこなっていることが明らかとなった。また、対象者を含め、社内の様々な部署、他機関と協力しながら、**【チームで支える】**ことのコーディネーター的役割を果たしていた。日頃より、健康と労働の調和にむけて健康支援をおこなっている産業保健師にとって、両立支援は保健師としての介入と一致しており、今後、より良い両立支援のために、求められる役割は大きいといえる。

Ⅰ．背景および目的

平成 28 年 2 月に厚生労働省から「事業者における治療と就業生活の両立支援のためのガイドライン」が公表された。近年の我が国の死亡原因は、がんによる死亡率が依然として高い状況にある。また、生涯でがんに罹患する日本人は、総人口の男性で約 6 割、女性では約 5 割という統計データがある。しかし、治療技術の進歩と共に、がんの治療を受けながら就労する労働者が増加している現状もあり、このガイドラインが公表された背景ともなっている。そして、がんだけでなく、医療の進歩で様々な疾病の治療法が擁立されるようになった。これにより、今後さらにがんなどの慢性疾患を持ち、治療を受けながら、就労する労働者が増加することが予想される。

労働が高齢化していく中で、このような労働者を支える必要があり、産業分野で働く看護職の役割はますます大きいと考える。平成 30 年度からは、全国の産業保健総合支援センターに保健師を常勤で雇用することが始まり、事業場内外を問わず、保健師の役割に対し期待されている。産業看護職には保健師と看護師がいるが、看護師は個別の健康支援であるのに対し、保健師は個人と集団の支援をおこなう看護職であることから、慢性疾患を持ちながら、就労する労働者に対して、現場で行われている産業保健師の取組みとその課題をあきらかにし、より効果的な産業看護職のあり方を検討した。

Ⅱ．研究方法

研究分担者がこれまでおこなっていた研究知見に加え、治療と就労生活の両立支援に関する文献から、産業保健師の機能と役割について検討をおこなった。

研究期間は 2017 年 6 月～2017 年 12 月である。

対象となる個人や事業場が特定されず、不利益を受けないよう倫理的配慮をおこなった。また、事業場の分析においては、同意を得た上でおこない、データ分析資料についても、研究終了後は適切に破棄をすることとした。

＜用語の定義＞

両立支援：治療と就労の両立を支援すること

産業保健師：産業現場において事業者・労働者双方の健康支援に携わる保健師

Ⅲ．結果

現時点で、両立支援において保健師や看護師に関する研究論文はほとんどない。

松本、五十嵐ら（2016）は、産業保健師を対象とした質的研究において、産業保健師の機能は【会社全体の仕組みづくり】【望ましい人事制度】【職場の協力を得る】【対象者への看護的支援】【チームで支える】の5つのカテゴリーを抽出していた。

1)【会社全体の仕組みづくり】

このカテゴリーは2つのサブカテゴリーから構成されており、産業保健師は＜会社のシステムのひとつとして機能＞しており、また、＜会社全体の体制づくり＞に関与していた。

2)【望ましい人事制度】

このカテゴリーは3つのカテゴリーから構成されており、産業保健師は＜就労規則に沿った対応＞を念頭に、その上で労務を担当している＜人事の協力を得る＞ことを行っており、さらに現就業規則では対応できない場合は、＜柔軟な人事制度への働きかけ＞をおこなっていた。

3)【職場の協力を得る】

このカテゴリーは5つのカテゴリーから構成されており、産業保健師は＜就業上の配慮を適切に職場に伝える＞ことをおこなっており、＜職場の理解を促す＞ことに丁寧にかかわっていた。その後、＜職場に就業上の配慮を実施してもらう＞ことをお願いし、＜職場の対応を確認＞していた。そして、＜職場風土醸成のためのラインケア＞をおこなっていた。

4)【対象者への看護的支援】

このカテゴリーは4つのサブカテゴリーから構成されており、産業保健師は対象者の＜医療状況のアセスメント＞を常におこなっており、＜本人の気持ちに寄り添う＞ことを心がけながら労働生活への支援をおこなっていた。また、将来的には＜本人の自立を支える＞ことを見据え、＜状況の変化に応じたこまやかな対応＞をおこなっていた。

5)【チームで支える】

このカテゴリーは、＜チームで対象者を支えていく＞の一つのサブカテゴリーから構成されているが、産業保健師は、治療を継続していく対象者に対し、主治医や産業医、管理監督者だけでなく、職場の人々、人事労務部、家族など関連する人たちを、対象者を支えるチームとしてとらえ、そのコーディネーションの要となっていた。

Ⅳ．考察

保健師の介入は、国際的にはミネソタホイールモデルであらわされており、個人・集団・組織・地域全体を対象に大きく5つに分類されている（図１）。

①サーベイランス、疫学調査、訪問（職場巡視）、健康診断

②受診勧奨やフォローアップ、ケースマネジメント、依頼された役割

③健康教育、カウンセリング、コンサルテーション

④多職種･他機関との協働､地域づくり、組織体制づくり

⑤アドボカシー、社会的マーケティング、健康方針の開発と実施

このような機能を考えると、今回得られた両立支援における産業保健師の機能と役割は、これらにあてはまると考える。

結果から得られた【会社全体の仕組みづくり】【望ましい人事制度】【職場の協力を得る】【対象者への看護的支援】【チームで支える】の産業保健師の機能の５つのカテゴリーを保健師の介入を関連づけながら、述べることとする（図 2)。

１.【会社全体の仕組みづくり】

産業保健師は、両立支援の会社が主体であり、そこに産業保健師が協力することで、より効果的な支援を展開することができると考えている。産業保健師は、前述の⑤の“健康方針の開発と実施”という介入にみられるよう、まずは会社側の方針として両立支援を進めていくことを明確に打ち出し、④の会社全体の仕組みづくりに取り組むことを促していく役割があると考える。

厚生労働省から公表された両立支援のガイドラインのなかでも、事業者（会社または企業と同意ととらえる）を主語として両立支援について述べられている。主体となる会社側へのアドボカシーや体制づくりを進めることが、産業保健師の役割としてあげられると考える。

樋口（2016）は『がん患者や家族の就労をめぐる政策』の中で、“患者と事業所との仲介・調整役が必要”と述べており、産業保健師が＜会社のシステムのひとつとして機能する＞という結果からも、産業保健師は対象者の健康状況と労働実態や労働環境を把握したうえで、会社の仕組みの中でこの仲介・調整役、すなわちコーディネーターの役割を担っていると考える。

２.【望ましい人事制度】

労働者として組織に所属している限り、その組織の就労規則に従う必要がある。両立支援において、対象者が治療を受けながら就労するには、様々な時間的配慮が必要となってくる。たとえば、受診するための時間や、体調が悪い際の早退や時差出勤など、同一疾病でのインターバルを置きながらの病休取得など、産業保健師は現行の就労規則を念頭にしながらも、対象者を中心により柔軟な就労規則を求めていると考える。岡田（2017）は、「休暇制度や勤務制度を組み合わせながら柔軟に対応しているが、対象者の個別性をどこまで配慮するかは課題がある」と述べている。よって、産業保健師は、人事部に両立支援についての理解を促し、対象者への両立支援が円滑に進むよう、柔軟な人事制度への変革へと導くことか望まれる。④の“組織体制づくり”や“多職種・多期間との協働”の介入がそれに相当すると考える。

３.【職場の協力を得る】

このカテゴリーは 5 つのサブカテゴリーから構成されていることからも、両立支援において、産業保健師は【職場の協力を得る】ことがとても重要なことと考えていることがわかる。

会社に両立支援を進めていく方針や体制、また就業規則が整っていても、職場の安全配慮義務を担う管理監督者や対象者をとりまく職場の人々の理解や協力は不可欠である。よって、産業保健師は、常日頃から、

管理監督者や職場の人々との良好な関係性から、両立支援を進めるにあたり、職場に対して主治医や産業医からの就業上の配慮をわかりやすく丁寧に職場に伝えていく役割があることが示唆された。健康状態と就労状況を照らし合わせながら、就労上の配慮をより具体的に示し、職場の理解を促し、都度都度確認しながら、対象者の疾患や支援についての理解を促すことが重要であると考えていた。

樋口は、『がん患者や家族の就労をめぐる政策』の中で、取り組むべき施策として５つの施策があるとしており、1 つ目に“職場でのがんの正しい知識の普及”等と述べている。また、平岡ら（2016）は、『がんと「働くこと」』の中で、“職場復帰の際に苦慮した項目として、支援を行う上で必要となる病気関連の情報や対応に関する項目が上位の多くを占めていた”と述べている。このことからも、両立支援において病名の開示の方法には配慮が必要であることを前提に、職場の疾病に関する情報の普及は重要で、それを産業保健師が担っている。

③の“健康教育”“コンサルテーション”機能がそれに該当する。

４.【対象者への看護的支援】

産業保健師は両立支援に関し、会社や職場への働きかけをしていくものの、もっともきめこまやかに接していくのは、対象者個人への支援である。その際、看護専門職として、対象者の病状や治療状況、労働状況や労働環境、家族の支援などさまざまな視点をもち、対象者を支えている。五十嵐（2017）は、“産業保健師は労働者の最も身近な産業保健専門職であることから、医療的知識を踏まえた上で、健康と就労と調和を図ることができる”と述べている。がんにおいては、予後の良し悪しで、支援の方法も刻刻と変わってくる。その状況に応じ、一人一人の個別性に沿いながら、きめこまやかに支援していくことが望まれる。

産業保健師は、対象者の治療の方向性の迷いやわざわざ病院に行くまでではないが、不安や不明を聞いてみたいといったことに丁寧に対応しており、[一緒に考えてあげることが一番役に立てているのかな][何か解決しなくてもよいみたいで、すごく安心されるようなんです]と、対象者の気持ちを理解し、寄り添う姿勢が大切であるとも考えていた。

平岡らは『がんと「働くこと」』の中で、“がん患者の就労支援において最も重要となるのは本人の意思である”と述べている。サブカテゴリーで＜本人の気持ちに寄り添う＞＜本人の自立を支える＞といったサブカテゴリーが得られたことからも、対象者にとって望ましい治療と就労の両立がなされるよう、看護の視点で働きかけることは重要である。岡田（2017）は患者会などセルフヘルプグループの紹介なども示しており、対象者の自立ということに対する社会資源の提案もおこなっていた。対象者自身への心身両面への健康支援は、産業看護職である保健師や看護師の最も専門的な機能であるともいえよう。

保健師の介入では②に相当する。

５.【チームで支える】

産業保健師は、対象者を主治医・産業医・管理監督者・人事部・職場の人々・家族等のチームで支えるという姿勢でおり、その

チームを動かし調整する役割があると考えていた。

がんなどは両立支援が長期になることが多いことから、チームで事例検討をおこなうなどして情報を共有し、記録に残す等知識を蓄積させていくことにより、担当する産業保健師の変更や、その他のチーム内のメンバーが変更になった際にも、スムーズに対応できるような取り組みを行うことが望ましいと考える。

保健師の機能の①に相当し、産業保健師は状況を常にアセスメントしながら、チームメンバーと情報共有し、対象者を支援する方向性をひとつにしていく役割が求められる。

今回の分析の対象となった産業保健師はいずれも先駆的とりくみをしている産業保健師であったことから、すべての産業保健師が個人だけでなく、企業全体に働きかけているのかは疑問である。今後、産業看護職である保健師・看護師の人材育成を引き続き、おこなっていく必要があると考える。

Ⅴ．結論

産業保健師による治療と就労の両立支援が、

【会社全体の仕組みづくり】【柔軟な人事制度】への働きかけを行い、上司や職場の理解を促しながら【職場の協力を得る】ことで、対象者の労働を対象者の周囲から支えていくことを進め、医療的な判断力や連携・調整力を発揮し、対象者自身を支える【対象者への看護的支援】をしていくことであることか明らかとなった。また、対象者を含め、会社全体、人事、職場、産業医、主治医等の他機関と協力しながら、【チームで支える】ことも重要であることが明らかとなり、

これらの機能と役割は、保健師の一般的な介入と一致しており、両立支援において産業看護職である産業保健師は最もその任に適しているといえる。

＜引用・参考文献＞

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・五十嵐千代：チームによる産業保健活動 産業医と他のスタッフとの連携， 産業保健 21,独立行政法人労働者健康安全機構,第 89 号,10-11,2017

・岡田睦美；がんにおける治療と仕事の両立支援～現状から見えてくる課題とこれからの取り組み・産業保健師の立場から～，健康開発，22（1），34－39，2017

・樋口明子；がん患者や家族の就労をめぐる政策，保健の科学，58(1)，4－10，2016

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・松本明加奈，五十嵐千代；企業における治療と就業の両立支援における産業保健師の役割と今後の課題，東京工科大学医療保健学部看護学科卒業研究，488－495，2016

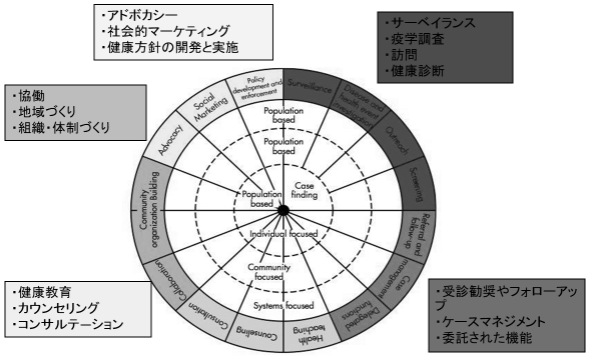

図1. ミネソタモデルにみる16の保健師の介入　Minnesota Department of Health Division of Community Health Services Public Health Nursing Section

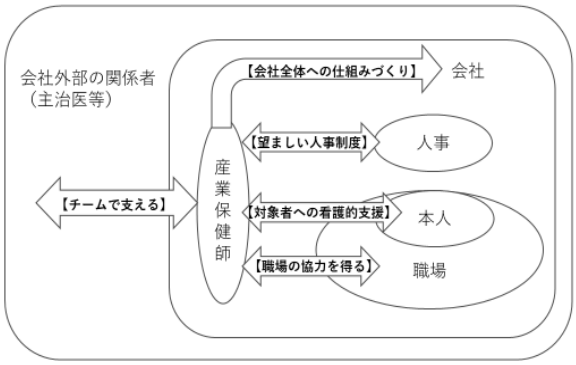

図2. 産業保健師による治療と就労の両立支援イメージ　（松本・五十嵐）

労災疾病臨床研究事業費補助金

平成 29 年度分担研究報告書

「仕事と治療の両立」支援に関する調査

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研究要旨

障がいや疾病により就労上の配慮を必要とする労働者が増加しており，事業所には労働者の必要と事業所側の事情を調整し，合理的配慮を検討・実行する仕組みを整えていく必要がある．今回，慢性疾患および障がいを有する従業員の就労支援経験の有無と支援内容の実態を明らかにすること，合理的配慮に関する意識と課題を明らかにすることを目的に調査を行った．石川県内の従業員数 50 人以上の事業所 1200 社を対象に調査協力依頼を行い，688 社より回答を得た．また，詳細調査に同意が得られた 8 事業所を対象に，支援の仕組み，具体的な支援内容，その効果等について半構造面接法による調査を行った．治療中の従業員利用できる制度は 454 事業所（66.7%）があると回答し，その内容は短時間勤務（60.6%），時間単位の有給制度（43.6%），療養休暇制度（48.0%）が多く挙げられた．時差出勤，在宅勤務は少なかった．復職面談は「たいていしている」が 459 事業所（67.2%）で，復職面談制度のあるところでは，産業医が関わる事業所は 166 事業所（30.1%）であった．就業上の配慮に際して困ったことでは「他の従業員との調整が難しい」が最も多く（53.0%），次いで「いつまで配慮すればよいのかわからない」（41.6%）であった．結果として仕事と治療の両立支援が出来たかについては「どちらともいえない」との回答が半数近く（44.9%）あった．過去 3 年間に病気と仕事の両立が困難になり退職した社員がいた事業所は 243（35.6%）であった．聞き取り調査が出来た事業所では就労支援に関する積極的な姿勢が伺われた．就労支援に係る制度については，時間有給を認めている事業所が少数あった．復職時には「業務量の調整や業務制限」，「短時間勤務」，「配置転換」，「復職後の業務遂行の確認」が配慮されていた．就労支援では上司がキーパーソンだとの指摘が多かった．また，本人からの情報提供が大切であり，本人が就労意欲を示し，必要な事項について申し出ることの必要性についても語られた．仕事と治療の両立支援には制度面と人的関係に係る面の二つの要素が重要と考えられた．制度面については，通常の制度の加えて柔軟な働き方ができる仕組みを整えていく必要がある．また，支援する側と本人との人間関係は重要であることが示された．

A.研究目的

わが国は超高齢社会となり，今後は人口減少が見込まれている．改正高年齢雇用安定法が 2013 年から施行されたことによる影響もあり，高年齢労働者は今後増加すると考えられる．必然的に健康上の理由により一時的に休職せざるを得ない事例が増えることが予想される．一方，医療や医学の進歩により，がんはかつてのように不治の病ではなく，緩解を維持しながら日常生活を送ることの出来る慢性疾患に変化してきている．しかし，実際には治療と職業生活の両立が困難となり離職を余儀なくされる事例は少なくないとされている．がんの就

労支援については，事業者，患者．医療従事者のそれぞれを対象にした，啓発のためのガイドライン，マニュアルが整備されてきている．2016 年 2 月には厚生労働省が，継続的な医療を必要とする労働者が適切な配慮や支援を受けることによって就労を継続できるように，「事業所における医療と職業生活の両立支援のためのガイドライン」を発表した．このガイドラインは疾患や障がいの種類は問わず活用できるものである．そこで，本研究では，両立支援に関する事業所の体制，認識，課題を明らかにし，産業保健の専門家として事業者や当事者に対する支援の構築に向けた基礎資料とすることを目的に調査を行った．

B. 研究方法

調査 1：質問紙調査

石川県内の従業員 50 人以上の事業所より層化無作為抽出した 1200 社を対象とした．無記名式質問紙調査を計画した．調査票の発送および回収はともに郵送法を用いた．調査内容は次のとおりである．①産業保健スタッフの選任状況，②慢性疾患および障がいを有する従業員が治療と職業生活を両立するうえで利用可能な制度の有無とその内容，③有給休暇をとることの障壁の有無，④仕事と治療の両立支援に関する情報の入手状況，⑤就業上の配慮に関する社内組織，外部との連携，⑥就業上の配慮が必要な労働者の有無と対応，⑦就労支援の課題．

調査 2：聞き取り調査

石川産業保健総合支援センターが実施する研修会等に参加のあった事業所に対してインタビュー調査を依頼した．その結果，8 事業所から同意が得られた．研究者が各業所を訪問し，半構造面接法による調査を行った．インタビューの内容は，①会社概要，②産業保健スタッフの選任状況，③両立支援に関する制度，④支援の経験（内容，苦慮・工夫点），⑤フォローアップの仕組み，⑥内部，外部との連携，⑦今後必要と思われること，⑧就労支援において大切なこと，とした．一事業所あたり 30 分から 40 分程度インタビューを行った．

調査 1 は単純集計を行い，設問ごとに有効回答票に対する割合を示した．調査 2 は，事業所における支援の仕組みや支援ないようについてまとめた．

倫理面への配慮

調査は産業保健調査研究倫理審査委員会の承諾を得て行った．質問紙調査はすべて無記名で実施し，回答をもって調査へ同意を得たと判断した．聞き取り調査については，調査目的および匿名性の確保について保障することを説明し，同意の得られた事業所に実施し，まとめにあたっては，事業所が特定されないように配慮した．

C. 研究結果

調査 1

688 事業所から協力が得られた（回収率：57.3%）．回答者の属性は「人事担当者」が 367 人（54.1%）ともっとも多く，次いで「衛生管理者」が 184 人（27.3%）であった．その他は，支店長，工場長，管理者といった事業所組織における管理職であった．事業所の構成については，従業員数が「50 人未満」が 39 事業所（5.8%），「50 人～99 人」が 300 事業所（44.6%），「100～299 人」が 255 事業所（37.9%），「300 人以上」が 78

事業所（11.5%）であり，50〜99 人の事業所が最も多かった．従業員の男女比は，「男性が多い」が 355 事業所（51.6%），「女性が多い」が 277 事業所（40.3%）であり，従業員の平均年齢は「40 代」が 415 事業所（62.0%）と最も多く，次いで「30 代」が 178 事業所（26.6%），「50 代」が 65 事業所（9.7%）の順であった．事業所の業種で最も多かったのが「製造業」の 206 事業所（29.9%）であり，次いで「卸売業・小売業」が 83 事業所（12.1%），「福祉」が 70 事業所（10.2%），「医療」が 53 事業所（7.7%）と続いた．

仕事と治療の両立支援に関する回答の結果を表 1 に示す．88.5%の事業所で産業保健スタッフが選任されており，98.7%の事業所で産業医を選任していた．治療中の従業員が利用できる制度があると答えたのは 66.7%の事業所であり，そのうち 6 割の事業所で短時間勤務を，5 割近い事業所が療養休暇制度をあげた．時間単位の有給制度は 43.6%の事業所で可能であった．通院治療のために有給休暇を取得することについて，62.8%の事業所では全体として取りやすい雰囲気であると回答したが，実際の有給休暇取得率は 6 割の事業所で 59.8%未満であった．

従業員の復職面談は，67.2%の事業所が「たいていしている」と答え，78.1%の事業所では上司が担当していた．65.3%の事業所で，治療を行いながら仕事をする従業員のために，業務上の配慮を必要とした経験があり，その疾患はうつ病，うつ病以外の心の病気，腰痛症，関節症，がんなどであった．仕事と治療の両立の状況については，42.9%の事業所では「うまくいったことの方が多い」と答えた一方，44.9%の事業所では「どちらとも言えない」と回答した．業務上の配慮に際して困ったこととしてもっとも多かったのは，「他の従業員との調整が難しい」，「いつまで配慮してよいのかわからない」であった．支援・配慮の決定にあたり連携した人としては，上司が最も多く（82.4%），本人（74.6%），人事担当者（58.4%），産業医（58.4%）が続いた．就業上の支援・配慮の内容は「仕事の内容を減らす」，「配置転換」，「仕事の内容の変更」，「短時間勤務」などが多かった．9 割近い事業所では就業や療養の状況を確認し，支援の見直しをおこなっており，その確認者は上司（77.6%），人事担当者（55.5%）が多かった．35.6%の事業所では，過去 3 年に病気と仕事の両立が難しいことを理由に退職した従業員がおり，退職に至った理由としては，「仕事をしながら治療を継続することが困難になった」，「病気が障がいが重くなった」などであった．治療と仕事の両立にために必要なこととしては，6 割以上の事業所が，同僚や部下の理解，本人の仕事に対する姿勢と回答した．

調査 2

対象事業所の従業員数は，100 人から 299 人が 2 事業所，300 人から 499 人が 2 事業所，500 人以上が 4 事業所であった．業種は製造業，卸小売，医療・福祉，運輸・交通業，専門・技術サービス業等であった．就労に関する企業方針としては，「ダイバーシティ部門の設置により，多様な人材雇用を推進している」，「雇用継続が最大のミッション」，「病気等による一時的なことで辞められるのは会社にとっても不利益」，「復

職しやすいように配慮する」等が挙げられた．

安全衛生管理体制については，安全衛生委員会が機能しており，事業所内で解決できないことや全社に周知が必要な事例について，本社，他の支店の衛生管理者や産業看護職との情報共有の機会を持っていた．すべての事業所が産業医と雇用契約を結んでおり，産業看護職については，3 つの事業所で常勤または非常勤として配置されていた．

就労支援に係る制度について，通院治療のための有給休暇制度は 1 時間単位で取得できる事業所，2 時間単位で取得できる事業所もあったが，多くは半日単位の取得となっていた．遅刻相対が 3 回で 1 日欠勤と査定するなど比較的柔軟に対応している事業所もあった．休職制度は 1 年 6 ヶ月等の制限付きで取得できる事業所がほとんどであった．半年以上の休職者の所属を人事部所属に変更している事業所もあった．休職者が出た場合に派遣従業員等を配置し，速やかに対応している事業所や，普段から互いにカバーし合えるような人事配置をしている事業所もあった．休職中の給与については，長期欠勤者の場合，職位や勤続年数に応じて減額され，支給期間も異なる事業所もあった．

勤務時間はフレックスタイム制や在宅勤務を導入していない事業所が大半であるが，フレックスタイム制を導入している事業所においても，コアタイムが通常勤務と変わらないため，通院治療には有益ではないとのことであった．

就労支援の経験について，支援が必要な従業員については，うつ病などのメンタルヘルス不調が多く，それ以外ではがん，難病，腎不全，脳卒中であった．就労支援の実際では，復職支援が最も多く，主治医の診断書に沿いながら本人の意向を重視した支援に努めている事業所がほとんどであった．復職にあたっては，産業医による復職面談の実施を位置づけた復職支援体制を構築しているが，そうでない事業所については，主治医の診断書と本人の意向を確認したうえで，総務や人事部で面談を行い復職につなげている事業所もあった．また復職時には，「業務量の調整や業務制限」，「短時間勤務」，「配置転換」，「復職後の業務遂行の確認」を実施している事業所がほとんどであった．その際，主治医に事業所が作成している診断書（修行制限の可否や内容について）に記載してもらい，それに基づき本人の意向を確認しながら行っていた．一方で業種によっては本人の状況に合わせた仕事の調整が難しかったために，退職せざるをえなかった事例を経験した事業所もあった．

就労支援の経験を持つ事業所においては，上手くいった事例もあるが，対応や判断に苦慮している事例も経験されていた．抗がん剤治療で外来通院している従業員が仕事を続ける上で，有給休暇制度などの見直しが必要と感じている事業所があった．また，仕事と治療の両立のために大切なことがらを尋ねたところ，職場の理解の重要性があげられた．そのためにも，本人からの情報提供が大切であり，本人が意思表示することの必要性について述べられた．

D. 考察

本調査に協力のあった事業所の規模は 50

人から 300 人未満が全体の 8 割をしめており，本調査結果は石川県の中小企業の実態を表していると考える．回答のあった多くの事業所では疾病や障がいを持つ本人から申し出があれば，仕事と療養生活が両立できるよう配慮や支援を行う姿勢を持っていることが分かった．多くは人事担当者，上司がかかわって支援や配慮の内容を決定し，フォローもしていたが，全体としてうまくいっているとは言い難い事情があることも伺われた．

外来通院のために相当時間を要する労働者が利用できる制度として普及していたのは，短時間勤務制度，有給休暇，療養休暇制度があげられた．しかし，最も高い割合であった短時間勤務制であっても，6 割にとどまっていた．有給休暇についても，通院の頻度によっては不足する可能性がある．その点，約 4 割の事業所で採用されていた時間単位の有給休暇制度は有用と考えられた．また混雑する時間をさけることの出来る時差出勤制度については 2 割の事業所にとどまっていた．制度があっても申し出しやすい雰囲気かどうかは重要な要素であるが，有給休暇取得について 6 割の事業所が取得しやすい雰囲気であると回答していたものの，回答事業所の実際の有給取得率は 50%未満が 6 割であった．

復職面談は 7 割の事業所で行われていた．面談を担当するのは上司が 8 割近くで，産業医は 3 割程度であった．両立支援に関しての連携としては，上司，人事担当者が上げられたが，主治医，産業間誤植といった保健医療の専門家の関与は少なかった．支援・配慮の内容としては，「仕事の量を減らす」，「仕事内容の変更」，「責任の軽減」など，現場の裁量にゆだねられる漠然としたものが多かったが，短時間勤務，通院の保障，勤務形態の配慮（夜勤を外すなど）も挙げられた．配慮や支援をおこなっている場合，9 割がその後の上司や人事担当者によるフォローアップも行っていた．結果として退職に至った事例を経験した事業所が 5 割程度あり，その理由は「病気や障がいが重くなった」,「両立が困難になった」,「仕事に適応できなくなった」などであった．配慮や支援の不足が原因なのか，就労不能な状況までに病状が悪化したのかについては区別できない．

聞き取り調査では従業員を大切にする企業理念がベースにあってこそ個々の事情に合わせた配慮がなされるとの基本的なことが語られた．産業保健を推進する専門職者が啓発活動や具体的に支援に関わる際に，企業文化の向上を目指すことを念頭に置く必要があると考えられた．また，今回事業所によって療養しながらも仕事を継続する上で有利な制度をもっているところもあった．事例が発生してから検討するのではなく，何もない時から制度を整備しておくことが大切であると考えられた．

今回の調査の限界は，回収率が約 5 割であったことである．回答の無かった事業所の実情は回答のあった事業所よりも厳しい可能性がある．また，今回は主として従業員数 50 人以上を対象としたことから，小規模零細事業所の実情も明らかではない．今後の検討課題である．

E. 結論

仕事と治療の両立支援には，制度面と人的関係に係る面の二つの要素が重要である

と考えられた．制度面については，通常の制度に加えて柔軟な働き方ができる仕組みを整えていく必要がある．また，支援する側と本人との人間関係は重要であることが示された．産業保健スタッフは専門的な知識と能力をもって，調整役を果たす役割があると考えられた．

F．研究発表

1. 論文発表なし
2. 学会発表なし

G. 知的財産権の出願・登録状況（予定を含む）

1. 特許取得なし
2. 実用新案登録なし
3. その他なし

表　質問紙調査の結果

質問項目	**n**	**(%)**
産業保健スタッフを選任 (n=688)	606	(88.5)
選任されている産業保健スタッフ (n=605 複数回答)		
産業医	598	(98.7)
保健師	58	(9.6)
看護師	51	(8.4)
カウンセラー	38	(6.3)
その他	21	(3.5)
治療中の従業員が利用できる制度がある (n=688)	454	(66.7)
制度の内容 (n=454 複数回答)		
短時間勤務	275	(60.6)
時間単位の有給制度	198	(43.6)
療養休暇制度	218	(48.0)
時差出勤制度	90	(19.8)
リハビリ出勤制度	74	(16.3)
在宅勤務	15	(3.3)
通院治療のために有給休暇取得について(n=681)		
全体として取りやすい雰囲気である	428	(62.8)
部署によって異なる	183	(26.9)
取りにくい雰囲気である	28	(4.1)
どちらとも言えない	42	(6.2)
事業所の有給休暇取得率 (n=676)		
70%以上	98	(14.5)
50～70%	146	(21.6)
50%未満	404	(59.8)
わからない	28	(4.1)
両立支援に関する研修会に参加した人がいる	226	(33.0)
両立支援に関するパンフレットやホームページなどを見たことがある	290	(42.2)

病気がケガのために長期に休んだ従業員が職場に復職する際に、復職面談をしているか		
たいていしている	459	(67.2)
時々している	112	(16.4)
していない	93	(13.6)
復職面談実施者 (n=552　複数回答)		
上司	431	(78.1)
人事担当者	267	(48.4)
衛生管理者	68	(12.3)
保健師・看護師	39	(7.1)
産業医	166	(30.1)
その他	23	(4.2)
過去 3 年に病気の治療を継続しながら仕事をする従業員のために、作業環境、作業内容などを変更するなどの配慮をした経験あり	448	(65.3)
就業上の配慮をした疾患 (n=445 複数回答)		
うつ病	288	(64.3)
腰痛症、関節症	119	(26.6)
うつ以外の心の病気	114	(25.4)
がん	114	(25.4)
仕事と治療の両立状況		
うまくいったことの方が多い	190	(42.9)
うまくいかなかったこの方が多い	26	(5.9)
どちらともいえない	199	(44.9)
わからない	28	(6.3)
就業上の配慮に際して困ったこと (n=438 複数回答)		
病気の内容や障がいの程度などの情報不足	129	(29.5)
必要な配慮がわからない	71	(16.2)
いつまで配慮すればよいのかわからない	182	(41.6)
職場の中で、情報を共有する範囲がわからない	115	(26.3)
他の従業員との調整が難しい	232	(53.0)
顧客など外部の関係者との調整が難しい	29	(6.6)
特にない	82	(18.7)
その他	10	(2.2)
現在、治療と仕事の両立のために支援や配慮を行っている従業員がいる	279	(62.3)
誰からの申し出で配慮を行ったか (n=279 複数回答)		
本人	238	(85.3)
家族	19	(6.8)
上司	81	(29.0)
人事担当者	44	(15.8)
産業医	48	(17.2)
就業上の支援・配慮の決定にあたり連携した人々 (n=279 複数回答)		
本人	208	(74.6)
上司	230	(82.4)
人事担当者	163	(58.4)
産業医	163	(58.4)
就業上の支援・配慮の内容　(n=278 複数回答)		
仕事の内容を減らす	142	(51.1)
配置転換	132	(47.5)
仕事の内容の変更	126	(45.3)
短時間勤務	108	(38.8)

ときどき就業や療養状況を確認して、支援を見直している	246	(88.2)
就業上の支援・配慮の確認者 (n=245 複数回答)		
上司	190	(77.6)
人事担当者	136	(55.5)
産業医	54	(22.0)
過去 3 年に病気と仕事の両立が難しいことを理由に退職した人がいた	243	(35.6)
退職に至った障害や病気 (n=239 複数回答)		
うつ病	136	(56.9)
うつ以外の心の病気	58	(24.3)
がん	35	(14.6)
腰痛症や関節症	47	(19.7)
退職にいたった理由 (n=235 複数回答)		
仕事をしながら治療を継続することが困難になった	106	(43.6)
病気や障がいが重くなった	98	(40.3)
仕事内容に対する不適応	72	(29.6)
治療と仕事の両立のために必要なこと (n=684 複数回答)		
同僚や部下の理解	427	(62.4)
本人の仕事に対する姿勢	415	(60.7)
上司の理解	364	(35.2)
事業所トップの理解	184	(26.9)

労災疾病臨床研究事業費補助金
平成29年度分担研究報告書

医療機関や産保センターの連携に関する質的研究

研究分担者　高橋美保　東京大学大学院教育学研究科　教授

研究要旨：本研究は、患者（就労者）が医療と職場の両方からの支援を、必要なタイミングで、より負担ない形で得るために必要な連携支援のあり方について、様々な立場の関係者によるグループフォーカスインタビューによって明らかにするものである。

A．研究目的

がんは死因の第1位であり、がん罹患者の3人に一人は就労世代である。しかし、がん診断後、治療開始までに患者の3割が離職しているという現状がある。政府主導により社会制度的支援や医療機関での窓口設置など、様々な施策が打たれているが、治療と就労の多面的な支援が必要であり、治療の段階で必要な支援も異なるため、複数の援助者がどのタイミングで、どのような連携を取ればより有効な援助ができるかについては十分な検討されていない。

そこで、本研究はがんの治療と就労の両立支援のために有効な連携モデルを検討するために、現状の問題点を明らかにすることを目的とする。

B．研究方法

【対象】10名の専門職（社会保険労務士3名、中小企業事業主1名、労災病院MSW(両立支援コーディネーター)、東大・リハ部OT/PT、NS、産保センター所長（医師））

【時間】9月8日(金)14:00-17:00

【場所】東京大学教育学部棟2階第1会議室

【調査】フォーカスグループインタビュー

【予備調査】参加者の社労士1名、OT1名に予備インタビューを実施（1～1.5時間）

【本調査事前手続き】事前に以下を送付

① 研究主任者からのメッセージ
② 参加者のプロフィールを収集・共有
③ インタビューガイド・両立支援基礎情報送付

【倫理面への配慮】

人を対象とする医学系研究に関する倫理指針に基づき、東京大学ライフサイエンス研究倫理支援室にて倫理審査を受けている。

C．研究結果

文字起こしをしてそれを読み込み、重要ラベルの作成、分類をしてカテゴリを作成した。分析の結果，7つのカテゴリ，22のサブカテゴリ，220の重要アイテムが生成された。なお，治療や就労の状況に応じて，がん診断直後後の「Ⅰ．初期治療」，手術・退院・復職を経て「Ⅱ．復職を考える」，病気が寛解して再発・病勢増悪する「Ⅲ．復職後の日々」の3つの時期が見出された。

問題として、3期にわたって、以下の5つの問題点が抽出された。

「Ⅰ．初期治療」の段階：＜問題①病院内（両立支援）システムが整備されていない＞＜問題②企業内（両立支援）システムが機能していない＞＜問題③医療－企業間の連携不足＞「Ⅱ．復職を考える」の段階：＜問題④院内連携の不足＞，＜問題⑤産保センターの機能不全＞，＜問題⑥ハブ機能を持つ機関の

「不在」と「乱立」＞、「Ⅲ.復職後の日々」に＜問題⑦長期的な支援の難しさ＞が見い出された。

D．考察

治療と就労の両立支援は、医療側と職場側に分断されて行われており、その各々において十分な対応がなされていないことが示唆された。また、それによって、結果的に患者（就労者）自身が両立のための情報を収集しなければならない状況にあることが示された。

さらに、現状では、がん相談支援センターや産保センターなど、医療側と職場側の窓口となるべき機関が存在はしているものの、いずれも十分に機能しておらず、場所によってはハブ機能が不在であったり、あるいは存在していたとしても混乱があることが示唆された。

さらに、がん告知や復職時だけでなく、中長期的な支援が必要とされていることが示されたが、「初期治療」「復職を考える」時期に十分な支援が確立していないため、その後「復職後の日々」の長期的な支援まで行き届いていない現状があることが示唆された。

E．結論

両立支援は、患者（就労者）が治療ルートの中で無理なくつながることができる入り口を設けること、さらに、中長期的な支援のためには、様々な専門家から必要なタイミングで支援が受けられるような連携が必要である。

G．研究発表

1. 論文発表　なし
2. 学会発表　なし

H．知的財産権の出願・登録状況

1. 特許取得　なし
2. 実用新案登録　なし
3. その他　なし

労災疾病臨床研究事業費補助金

平成 29 年度分担研究報告書

企業・産業保健スタッフ・医療機関の連携による両立支援システムの開発

治療と就労の両立支援を実現させるための運動・身体活動プログラムの開発

研究分担者　野村卓生　関西福祉科学大学　保健医療学部　リハビリテーション学科　教授

研究要旨

本研究では治療と就労の両立支援を実現させるための運動・身体活動プログラムの開発を最終目的とし，研究初年度については，医学中央雑誌 web を用いて国内の学術論文から過去 10 年間の情報を収集することとした．本研究では，身体機能・能力に障害の発生が予想され，治療と就労の両立支援で最も重要視される「がん」を中心にした．また，「脳卒中」「糖尿病」「メンタルヘルス」の計 3 分野も傾向をみることとした．結果，職場における実践的な報告は今回の検索方法では皆無であり，これは脳卒中，糖尿病，メンタルヘルス領域でも同様であった．国内の学術論文で紹介される論文からは運動・身体活動の有効性が示されているので，これらの情報を活用して職場に適したものにする必要がある．運動療法が専門でない医療者への情報提供を考慮するのはもちろんのこと，現場の健康管理を担当する者および患者本人に対して，職場環境や働き方に応じて受け入れられやすく，分かりやすい運動・身体活動プログラムを提示する必要がある．

A. 研究目的

近年の医学の進歩は，かつて不治の病とされていた病気の生存率を向上させ，長く付き合う病気に変化させつつある．一方，疾病や障害を抱える労働者の中には，①仕事上の理由で適切な治療を受けることができない場合，②労働者自身の疾病についての理解不足の場合，そして③職場の理解・支援体制不足などにより離職に至る場合がある．少子高齢化で労働力が低下している中，本邦の生産性を維持向上させるためには，労働力の確保が喫緊の課題である．女性や高齢者雇用の充実に加え，病気を抱えながらも，労働者が仕事を理由として加療機会を逃すことなく，かつ治療の必要性を理由として職業生活の継続を妨げられることなく，適切な治療を受けながら働き続けられる社会を目指さねばならない．

医療現場での集中的な治療後において，がんに罹患した者では，運動の継続，身体活動を維持・向上させることにより身体機能・能力の維持に有効である [1,2]．脳卒中に罹患した者では，運動の継続，身体活動を維持・向上させることにより，身体機能・能力の維持はもとより，脳卒中の再発予防に寄与できる [3,4]．糖尿病に罹患した者では，運動・身体活動が基本治療となり，疾病の増悪や合併症の発症を予防することができる [5,6]．メンタルヘルスには，脳内の神経伝達物質が影響を及ぼしており，適度な運動によってセロトニンなど脳内の神経伝達物質を増やし，心の健康を保持することができる [7,8]．

治療と就労の両立支援において，運動の継

続，身体活動の維持・向上は，がん・脳卒中・糖尿病に罹患した労働者にとって必要不可欠であると考えられるが，職場で行う，職場環境に応じたプログラムに関しては十分に検討されていないと思われる．本研究では治療と就労の両立支援を実現させるための運動・身体活動プログラムの開発を最終目的とし，研究初年度となる平成 29 年度については国内の文献情報を整理することとした．

B. 研究方法

就労と治療の両立支援を実現させるための運動・身体活動プログラム開発を行うために 3 年度にわたる研究を計画することとした（図 1）．研究初年度の 2017 年度については，国内の学術論文から情報を収集するために，医学中央雑誌 Web を使用した．また，本研究では，身体機能・能力に障害の発生が予想され，治療と就労の両立支援で最も重要視される「がん」を中心にすることとした．また，「脳卒中」「糖尿病」「メンタルヘルス」の計 3 分野も傾向をみることとした．

国内の知見の情報収集

医学中央雑誌 Web を使用し，検索方法を統制し，表 1 のように検索キーワード（タイトルおよび抄録）を設定した．絞り込み条件として，論文書類を原著論文・解説・総説，会議録を除く，論文言語は日本語，収載誌発行年は 2008 年から 2017 年の 10 年間，チェックタグをヒトとした．タイトルと抄録の検索に以下の検索キーワードを用いることとした．検索は 2018 年 2 月 4 日に行った．抽出された文献は，当該分野での活動を日常の業とする理学療法士がレビューを行った．

表 1．検索分野と検索キーワード

分野	検索キーワード
がん 1	がん　運動
がん 2	がん　身体活動
脳卒中 1	脳卒中　運動
脳卒中 2	脳卒中　身体活動
脳卒中 3	脳卒中　再発予防　運動
脳卒中 4	脳卒中　再発予防　身体活動
糖尿病 1	糖尿病　運動
糖尿病 2	糖尿病　身体活動
糖尿病 3	糖尿病　重症化予防　運動
糖尿病 4	糖尿病　重症化予防　身体活動
メンタル 1	メンタルヘルス　運動
メンタル 2	メンタイルヘルス　身体活動

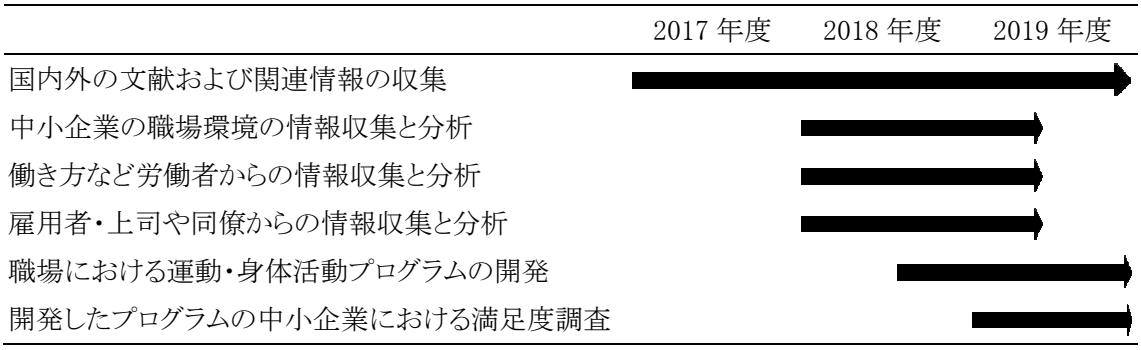

図 1．治療と就労の両立支援を実現させるための運動・身体活動プログラム開発を目的とした研究計画（2017 年度版）

表 2. 抽出論文数

分野	抽出件数
がん 1	419
がん 2	101
脳卒中 1	975
脳卒中 2	45
脳卒中 3	19
脳卒中 4	3
糖尿病 1	2,373
糖尿病 2	214
糖尿病 3	5
糖尿病 4	4
メンタル 1	122
メンタル 2	41

C. 研究結果

表 2 に抽出文献数と採用文献数を示す. がん患者のリハビリテーション(運動療法プログラム)の紹介は, American Cancer Society(ACS)や American College of Sports Medicine (ACSM)の内容が中心であった. 本邦におけるエビデンスの紹介は日本リハビリテーション医学会によるがんのリハビリテーションガイドラインを参照しているものが多かった. 周術期や罹患後のリハでは有酸素運動と筋力トレーニングの組み合わせであるが, 負荷は疾患により傾向はあるものの一定ではなかった. がんを予防する運動のエビデンスとしては, World Cancer Research Fund International (WCRF)や American Institute for Cancer Research (AICR)などによれば, 活動量増加が結腸がんの予防効果は確実であり, 乳がんや子宮体がんも可能性が高いとしているが, 運動内容は活動量の増加であり, 1 日のエネルギー消費量/1 日の基礎代謝量で 1.6 以上を目標値としている. 日本では国立がん研究センターの多目的コホート研究からのエビデンスで, 男性で結腸癌と肝がん, 女性で胃がんの活動量との関係が公表されているが, 明確な運動内容については示されていなかった(がん領域における文献の一部を追補に示す).

職場における実践的な報告は今回の検索方法では皆無であり, これは脳卒中, 糖尿病, メンタルヘルス領域でも同様であった.

D. 考察

がん罹患後のリハビリテーション, なかでも運動療法プログラムとしては有酸素運動と筋力トレーニングの組み合わせが多く報告されていた. 予防を目的としても活動量を上げるということはエビデンスであるので, 勤務中の活動量を上げる工夫を提案する事が現実的かもしれない. 近年, 糖尿病とがん, 特にインスリン抵抗性との関連から糖尿病の予防ががん予防に繋がる可能性も報告されており, また, 座位時間の長さと死亡率との関連なども含め, 業務中に一定の活動量を推奨することが望ましいと思われる.

例えば, 文献検索において, がん罹患後の運動療法プログラムとして, 自転車エルゴメータを用いた運動療法の有効性を報告されていたとしても, 退院後, 自宅や職場での自転車エルゴの利用は難しい場合が多い. 他のプログラムにおいても, 運動強度(Mets 数や 1RM)など医療機関, 運動療法専任のスタッフでなければ管理が難しいかもしれず, 運動療法が専門でないことはもちろんのこと, 医療者ではなく現場の健康管理を担当する者, および患者本人に対して, 職場環境や働き方に応じた受け入れられやすく分かりやすいプログラムを提示する必要があると考える.

E. 結論

・研究初年度については，国内の学術論文から過去 10 年間の情報を収集することとした．
・本研究では「がん」を中心とし，「脳卒中」「糖尿病」「メンタルヘルス」の計 3 分野も傾向をみた．
・結果，職場における実践的な報告は皆無で，これは脳卒中，糖尿病，メンタルヘルス領域でも同様であった．
・運動・身体活動の有効性が示されており，これらの情報を活用して職場に適したものにする必要がある．
・職場環境や働き方に応じて受け入れられやすく，分かりやすい運動・身体活動プログラムを提示する必要がある．

研究発表

なし

知的財産権の出願・登録状況

なし

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追補．がん領域の文献テーブル

No	文献情報	概　要
1	肺がん，大腸がんに対する運動介入効果　システマティックレビューによる検討．理学療法科学 32(1): 21-27, 2017	肺がん患者の周術期の運動では，自転車運動を予測最大心拍数の 50-80%，主要な筋群に対し 1RM の 60%負荷で 10～15 回を 3 セット実施．大腸がんでは歩行訓練や自転車エルゴを予測最大心拍数の 30～70%で実施．いずれも介入時間は 20～40 分で状態により調整．肺がん患者には有酸素運動単独か有酸素運動とレジスタンス運動の併用がよく用いられており，大腸がんは有酸素運動単独が介入方法としてよく用いられている．
2	乳がん・婦人科がんにおける術前術後のリハビリテーション．The Japanese Journal of Rehabilitation Medicine 53(2): 119-123, 2016	化学療法・放射線療法実施中は，有酸素運動と抵抗運動の組み合わせた運動療法が勧められる．有酸素運動-60%最大心拍数・10～15 分から開始し，最終的に 80%最大心拍数・45 分まで斬増する．週 3 回程度の抵抗運動-10RM の負荷量で，マシンもしくは重錘を用い 9 種類程度の上下肢体幹筋に対する抵抗運動をそれぞれ 8～12 回ずつ，週 2～3 回程度実施．治療後も 70%最大心拍数から開始し最終的に 80%，45 分程度まで漸増する報告が多い．6～12 週程度の実施で効果が報告されている．
3	肺がん患者の倦怠感に焦点を当てた運動介入研究に関する文献レビュー　倦怠感のセルフマネジメントに対する看護支援への示唆．せいれい看護学会誌 6(1): 14-20, 2015	年齢推定最大心拍数や最大仕事量，最大酸素摂取量の 60-90%と概ね中～高強度．在宅運動では，Borg scale や Mets を利用し，低～中強度に設定．レジスタンス運動の場合は 1RM の 60-90%，15RM のゴムバンド等，中～強度に設定．頻度は 2-6 回/週，期間は大半が 8 週以下で 6 又は 8 週間が多かった．
4	保存的治療が適応となるがん患者に対する低強度運動が身体活動量，身体・精神症状，QOL におよぼす影響．Pain Rehabilitation 5(1): 36-42, 2015	起立動作，歩行，階段昇降，ADL 運動などを，上限心拍数の 40%以下，20～40 分/日，3～5 回/週で実施した．歩行や階段昇降を中心とした低強度運動であっても保存的治療が適応となるがん患者の身体活動量が向上し，痛みや倦怠感といった身体症状や不安・抑うつなどの精神症状の改善が得られることが示された．
5	化学療法中の患者に対するリハビリテーション．MEDICAL REHABILITATION 173: 39-42, 2014	60-80%の負荷での有酸素運動，スクワットや腕立て伏せなどのレジスタンス運動を推奨．健康づくりのための運動基準である 23METs/週は 1 日 8000～10000 の歩数に相当することから，がん患者にも適応できると推察している．
6	乳がん治療におけるリハビリテーション．MEDICAL REHABILITATION 173: 14-22, 2014	有酸素運動は中～高強度（50～80%最大心拍数）でのエルゴメータやウォーキング，抵抗運動は 8～15 回繰り返す事の出来る負荷量（60～70%1RM）やマシンや重錘を用いて行い，週 2～3 回で 1 回あたり 20～30 分のプログラムを紹介している．

7	肝がん肝切除手術における運動療法とは. 消化器外科 Nursing 18(1): 75-77, 2013	肝切除術(肝臓の一部を切除)を予定されている患者に, 手術 1 カ月前から外来・入院を利用して CPX を実施. 患者それぞれに合った「ほどよい強さを保った運動を継続すること」, AT レベルの運動を一日 30 分程度継続することが重要である. 激しすぎる運動は効果が見込めないことを示唆している.
8	がんに伴う倦怠感に対する低強度運動の可能性. リハビリテーション科学ジャーナル 6: 79-87, 2011	極低強度の運動介入であるプラセボ群でも運動介入効果が得られていることから低強度運動の有効性に関する可能性を示している.
9	エビデンスに基づいた運動療法・運動処方 健康支援・疾病予防に対するアプローチ がん. 臨床スポーツ医学 27: 1231-1237, 2010	身体活動量は 5 段階の分類で, 男性では結腸癌と肝がん, 女性で胃がんが, 身体活動最大グループにて有意に罹患リスクの低下. またインスリン抵抗性との関連を示唆している.

労災疾病臨床研究事業費補助金

平成 29 年度分担研究報告書

企業・産業保健スタッフ・医療機関の連携による両立支援システムの開発

量的研究データ分析

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研究用紙：企業における両立支援への認識は、昨年「事業場における治療と職業生活の両立支援のためのガイドライン」の公表以降、高まりつつあるが、事業場数で 9 割以上を占める（労働者数 50 人未満の）中小企業への両立支援は未開拓分野である。事業場の課題は、労働者が就労を継続できるような就業上の措置を、がんの種類を含む疾病の固有性も考慮しつつ行うことであるが、両立支援という概念が浸透していない状態ではそれも難しい。中小企業への両立支援の普及を目的に、ソーシャルマーケティングを加味した探索的統計手法による、対中小企業の両立支援活動評価指標案の作成するため、本年度は基礎データの途中解析を行った。

労働者健康安全機構の「治療と就労の両立支援マニュアル」、分担研究者の横山が松平と共に前研究班で作成した「両立支援連携ガイドライン」、分担研究者の遠藤が作成した「企業の病休/復職制度等とがん/脳卒中の復職率等の評価指標の質問票」等の既存の成果物・調査票及び健康経営優良法人認定制度（中小規模法人部門）の評価項目をもとに、各疾患の専門家を交え中小企業に向けた効果指標を検討し、事業所に配布する質問票を作成した。

調査コホートとして、産業保健総合支援センター、中小企業産業保健事業の窓口である東京商工会議所、全国健康保険協会（千葉支部）、京都工場保健会等の協力のもと、11 月より 5,000 社に配布し、1,026 社より回答を得た。解析が完了した 576 社において、がん職員を有したのは 40%であり、その内約 7 割の会社で全員復職していた。全員復職していた 576 社では「両立支援についての社員に教育、啓発が進んでいる」「社員が相談できる窓口がある」「職場が両立支援に理解がある」などの特徴を持つことが明らかになった。

A. 研究目的

近国立がん研究センターの推計にて、年間約 100 万人が新たながんと診断され、その 3 割が就労世代である。少子高齢化に伴う人材難による定年年齢の引き上げ、働く女性の増加と乳がん罹患者の増加等から、がん罹患労働者、特に医療の進歩を背景にしたがんサバイバー労働者は急増することが見込まれる。

大企業における両立支援への認識は、昨年「事業場における治療と職業生活の両立支援のためのガイドライン」の公表以降、高まりつつある。平成 28 年度末には、労働者健康安全機構が「治療と就労の両立支援マニュアル（がん、脳卒中リハ、糖尿病等）」を公表、また今回の分担者の横山は前

研究班で「両立支援連携ガイドライン（がん、糖尿病、難病等）」を作成しており、産業保健スタッフが充実する大企業への両立支援は、機構等において、本年度から実践、周知、普及のフェーズに入ったといえる。

しかしながら、事業場数で 9 割以上を占める（労働者数 50 人未満の）中小企業への両立支援は未開拓分野である。事業場の課題は、労働者が就労を継続できるような就業上の措置を、がんの種類を含む疾病の固有性も考慮しつつ行うことであるが、両立支援という概念が浸透していない状態ではそれも難しい。中小企業への両立支援の普及を目的に、ソーシャルマーケティングを加味した探索的統計手法による、対中小企業の両立支援活動評価指標案の作成するため、本年度は基礎データの途中解析を行った。

B. 研究方法

復職・離職・休業に関する効果指標を選定するにあたり、ガイドラインで取り上げられる主要疾患の職場で配慮すべき事項は、労働者健康安全機構の「治療と就労の両立支援マニュアル」、分担者の横山が松平と共に前研究班で作成した「両立支援連携ガイドライン」にて検討済みである。さらに分担者の遠藤は企業の病休/復職制度等とがん/脳卒中の復職率等の評価指標の質問票を作成し、全国 70 社からデータを収集した実績を持つ。本研究では、上述した既存の成果物・調査票及び健康経営優良法人認定制度（中小規模法人部門）の評価項目をもとに、各疾患の専門家（研究分担者：遠藤、野村、協力者：豊田、黒澤）も交え中小企業に向けた効果指標を検討し、事業所に配布する質問票を作成した。

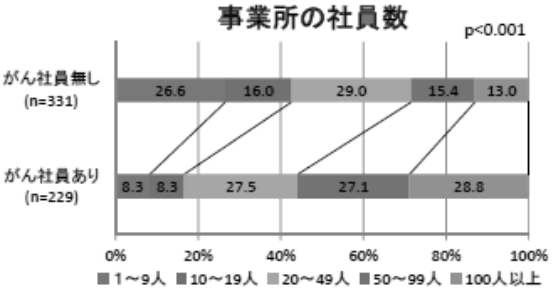
作成した調査票を石川産業保健総合支援センター、一般財団法人京都工場保健会、全国健康保険協会千葉支部、東京商工会議所サービス・交流部の協力のもと 11 月より 5,000 社に配布し、回収・解析を行った。

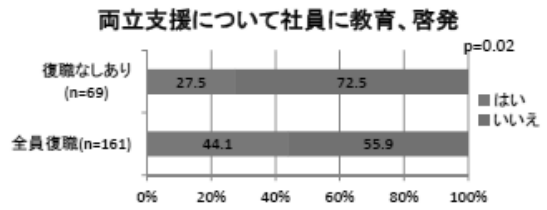
（倫理面への配慮）

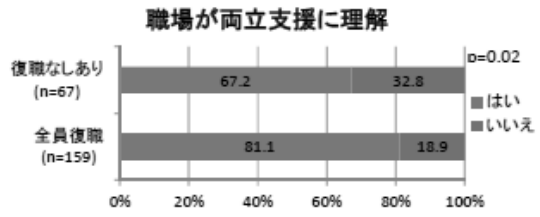
東京大学倫理委員会等にて、審査番号 11729「企業・産業保健スタッフ・医療機関の連携による、がん患者の治療と就労の両立支援システムの開発」として承認を得て、研究を実施している。本研究課題は、各種法令等、特に「人を対象とする医学系研究に関する倫理指針」および、東京大学が定めた倫理規定を遵守して行う。

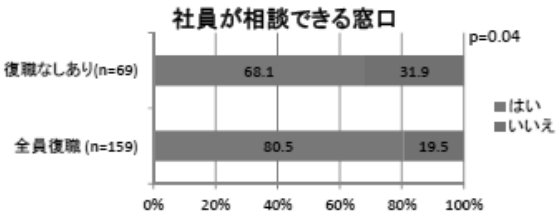
C. 研究結果

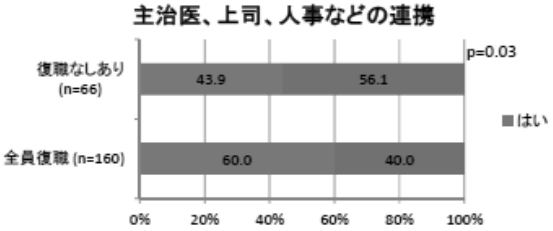
11 月より 5,000 社に配布し、1,026 社より回答を得た。解析が完了した 576 社において、がん職員を有したのは 40%であり、その内約 7 割の会社で全員復職していた。全員復職していた 576 社では「両立支援についての社員に教育、啓発が進んでいる」「社員が相談できる窓口がある」「職場が両立支援に理解がある」などの特徴を持つことが明らかになった。











D. 考察

2018 年度の診療報酬改定答申にがん治療と仕事の両立を目指し、がん治療と仕事の両立を診療報酬で評価すると記載された。このような取り組みが広がり、人員確保にも寄与することが期待される。また、保健師などの事業所内スタッフによるケアが高いニーズがある。両立支援を推進するにあたっては小規模事業場の産業医選任助成のような、保健師選任助成も対策として選択肢の一つとして考えられる。事業場での保健師選任が進めば、その他の課題である、不安感への対応や具体的な支援方法にも柔軟に対応できる可能性がある。

E. 結論

両立支援は、患者（就労者）が治療ルートの中で無理なくつながることができる入り口を設けること、さらに、中長期的な支援のためには、様々な専門家から必要なタイミングで支援が受けられるような連携が必要である。

F. 健康危険情報

該当なし

研究発表

なし

知的財産権の出願・登録状況

なし

労災疾病臨床研究事業費補助金
平成 29 年度分担研究報告書

治療と職業生活の両立支援における医療機関の役割
－ 中小企業を含めた職域・産業医との連携の分析と取組み －

研究分担者　横山　和仁　順天堂大学医学部衛生学講座　教授

研究要旨

近年、働き方改革の一具体策とあいまって労働衛生上の重要な課題となっている治療と職業生活の両立支援は、治療の進歩による疾病予後の向上、日本社会の少子高齢化に伴う高年齢就業者の増加と労働力不足、企業の人材活用への取組みの進展、そして英国の Fit Note 制度をはじめとするプライマリケアと産業保健の接近というグローバルな潮流を背景とする。両立支援推進のためには、特に重症化予防（２次予防）と職場復帰支援（３次予防）の観点から、主治医と産業医のより一層の連携・協力が求められるが、主治医による社会的処方という考え方とあわせ、医療機関が、中小企業で働く患者の両立支援にどのように取り組むべきか、その具体的な在り方が議論となっている。本研究では、先行研究で作成した連携ツールを実効的に活用するために求められる、医療機関・企業間の連携（C2C (Clinic to Company) collaboration)）推進のために、各組織がその内部で導入をめざすべき、両立支援体制（システム）の在り方の提示を目指す。本年度は、重症化予防（2 次予防）と職場復帰支援（3 次予防）のそれぞれにおいて、行動医学の観点からの横断分析を実施した。

生活習慣病における健診後の医療機関受療行動解析と行動予測モデル構築（重症化予防をめざして医療機関が果たすべき両立支援の在り方）研究では、レセプトビックデータの解析から、受療行動推進／抑制因子とその影響度の大きさが明らかとなった。影響の大きい促進因子として、高年齢・ハイリスク・3 疾病のなかでは血糖（糖尿）・生活習慣改善の行動期や関心期・食べるスピードが速いことの因子が抽出された。影響の大きい抑制因子としては、就労や年齢が若いことが抽出された。妥当性検証とあわせ較正能のよいモデルが構築され､受療行動予測モデルを活用し層別化を行った precision preventive medicine を実践できる連携モデルをめざす。職場復帰支援の観点では、先行研究の医療機関のみならず、職域でも支援体制のシステム整備が連携推進に寄与することが明らかとなった。特に安価で簡便に導入可能な連携様式等のマニュアルを整備することの重要性が示唆され、今後、ポータルサイトなどのプログラムやダウンロード式で、中小企業などでも簡便に活用できるモデル構築を図る。さらに、医療機関でのがん相談支援センターや難病相談支援センター等を活用して、主治医による社会的処方（social prescribing）のサポートを院内多職種チームで実施していくシステム構築の第一段階を実施した。院内の患者目線の動線が支援部門に向かうことをめざしたツールを作成し、特に産業保健スタッフ・リソースの活用が困難なことも多い中小企業勤務者・自営業者等に対する強力な empowerment をめざした。治療と職業生活の両立について、薬剤の副作用と業務内容の調整・配慮項目等、各疾患別に取りまとめが進むツールを院内で効果的に活用できるシステムを来年度以降さらに拡充するとともに、運営の評価改善をめざしていく。

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A.研究背景および目的

近年わが国では、疾病治療と職業生活の両立支援の機運がこれまでにない高まりをみせている。この背景として、①治療の進歩による疾病予後の向上、②日本社会の少子高齢化による労働力不足と高年齢就業者の増加、③ワークライフバランスやダイバーシティ、健康経営の概念の普及に呼応した企業の人材活用への取り組み、④「事業場における治療と職業生活の両立支援のためのガイドライン（平成28年2月、厚生労働省）」公表をはじめとする行政の取り組み、⑤プライマリケアと産業保健の接近／連携に向けたグローバルな潮流[1)]（英国家庭医（General Practitioner(GP)）での Fit Note(The Statement of Fitness for Work)制度導入[2)]）といった要因があげられる。英国のこの制度は、’Sick Note to Fit Note’という言葉が示すように、それまで患者の仕事に関して「病休診断書」だけ作成していた家庭医が、患者の職業生活を考慮した「復職・両立意見書」を作成するという大きな意識改革も伴っている。このように患者の well-being の推進をめざした主治医による social prescribing（社会的処方）が近年、欧州を中心に注目されている[3)]。わが国でも、「ニッポン一億総活躍プラン（平成28年6月閣議決定）」の実現へ向けた大きな具体的な柱である働き方改革の検討課題の一つとして両立支援が提起されており[4)]、具体的な方策の提示が喫緊の課題である。

「治療と職業生活の両立」とは、厚生労働省検討会[5)]によれば、「病気を抱えながらも働く意欲・能力のある労働者が、仕事を理由として治療機会を逃すことなく、また、治療の必要性を理由として職業生活を妨げられることなく、適切な治療を受けながら生き生きと就労を続けることである」とされる。両立

に困難を抱える人は、職場復帰に向けて治療中の正規雇用者推計値として約100万人にのぼるとされる[5]。また労働安全衛生法に基づく定期健康診断結果の有所見率は 53.0%(平成25年)と過半数を上回る。このようにがん、糖尿病などの生活習慣病、メンタルヘルス不調をはじめとする疾病を抱えながら働く人が増加する一方で、発症後も就労継続の意向をもつ人は疾病全体では９割以上[6]、がんに限定しても８割以上[7]に及ぶ。これらの有病労働者の両立支援の具体策として、「仕事を理由として治療機会を逃すことなく」に対しては、糖尿病をはじめとする生活習慣病やがんの早期発見・受診勧奨・受診継続支援といった重症化予防（２次予防）が考えられる。また、「治療を理由とした職業生活を妨げられることなく」に対しては、がん・脳卒中・メンタルヘルス不調・難病をはじめとする疾病の職場復帰支援（３次予防）が考えられる。

この重症化予防と職場復帰支援の両者において、「事業場における治療と職業生活の両立支援のためのガイドライン」では、関係者間の連携の重要性が指摘されている。特に「労働者の同意のもとでの産業医、保健師、看護師等の産業保健スタッフや人事労務担当者と主治医との連携（事業場と医療機関の連携)」の重要性が強調されており、先行研究では、産業医・主治医・事業者といった「関係者個人」向けの３種「連携ガイド」と「主治医向け教育プログラム」が開発されている[8]。本研究では、これらのツールを実効的に活用するために求められる、医療機関・企業間の連携(C2C (Clinic to Company) collaboration))を推進するために、各組織がその内部で導入をめざすべき、両立支援体制（システム）の在り方の提示を目指す。本年度は、重症化予防(2次予防)と職場復帰支援(3次予防)のそれぞれにおいて、行動医学の観点からの横断分析を実施する。

B.研究方法

【１】生活習慣病における健診後の医療機関受療行動解析と行動予測モデル構築（重症化予防をめざして医療機関が果たすべき両立支援の在り方)

生活習慣病有病者の中には、特に就労世代を中心に、多くの未治療者や治療中断者が存在することが示唆されているが、正確な実態は明らかでない。本研究では、レセプトデータベースを用いて、健診で受診勧奨判定を受けた場合の、医療機関受療行動を解析し、重症化予防のための健診（職域）と治療（医療機関）の連携行動分析を行った。日本医療データセンター(JMDC)が保有する全国80健保の健診およびレセプトデータ(20-74歳)を用いた(2008年4月-2016年3月)。健診で血圧・血糖・脂質いずれか一つ以上の特定保健指導受診勧奨判定基準に該当し、かつ健診受診月より過去 4 か月に当該項目のレセプト（病名または処方）がない 533,955 人(男387,440(就労者 99.8%、女 146,515 人(同40.1%))を対象とした。健診受診後1年間の初回医療機関受療行動を追跡し、当該項目のレセプトが発生した場合を受療と定義し、カプランマイヤー法で累積未受療率を推定した。さらに、Cox 比例ハザードモデルを用いて未受療率に対する予測モデルの構築を、TRIPOD statement に準拠して実施した。統計ソフトはStata 14を使用した。

【２】職場復帰 (Fitness for Work)・就業継続 (Stay at Work) 支援を医療機関で推進するための基礎データの分析と実践に向けた取組み

本研究では、連携推進のために組織がどのような体制を整えることが望ましいか、連携

行動に寄与する因子の分析を行った。日本産業衛生学会産業医部会所属の産業医 1102 名を対象に、属性、連携に対する意識と行動（年あたり連携回数）、事業場の支援体制について、選択式質問紙法で調査を実施した（2015 年 11-12 月）。

統計解析は IBM SPSS Statistics 22 を使用した。倫理的配慮として、上記の研究は順天堂大学医学部倫理委員会の承認（第 2015102 号）を受けた。

C. 研究結果

【1】生活習慣病における健診後の医療機関受療行動解析と行動予測モデル構築（重症化予防をめざして医療機関が果たすべき両立支援の在り方）

健診後 3,6,9,12 か月後の未受療率は、各々 91.4, 88.2, 86.2, 84.4 %だった。疾患別の健診 1 年後未受療率は、血圧・血糖・脂質につき各々、84.3, 67.9, 86.1 %で、2 疾病以上合併では 69.8%だった。重症群全体（下記 1 項目以上：sBP 160 or dBP 100mmHg 以上、HbA1c 8.4% or FBS 166mg/dL 以上、LDL 160 以上 or HDL 34mg/dL 以下）では、74.0%であり、特に血糖では 51.9%、2 疾病以上合併では 63.5%と比較的受療行動を認めた。特定保健指導開始後早期と直近では変化がなかった。女性のうち就労者（保険種別本人）の未受療率は 85.6%と男性とほぼ同一で、扶養家族の場合は 79.8%だった。所属健保の規模の差は僅かだった。次に、受療行動予測モデル構築をめざして、予測因子の抽出を行った。健診時の問診項目ならびに検査項目について、下記を投入した。性・年齢・就労の有無（保険種別）・BMI・腹囲・血圧値・脂質値（LDL, HDL, TG）・血糖値（FBS, HbA1c）・肝機能値（AST, ALT）・自覚症状の有無・身体所見の有無・喫煙・食行動・飲酒・睡眠状況・体重変化・運動習慣・行動変容の意思（段階）・保健指導希望の有無。Logistic regression models (step wise 法)にて p 値<0.05 の因子を抽出し、β coefficients を算出した。その結果、上記項目のうち、BMI・喫煙・運動習慣を除いた全項目が p<0.05 を示した。以下にこれらのβ coefficients ならびにそれにより重みづけをしたスコアを示す。

このモデル構築には、全項目で欠損値がない 240,000 人をランダムに等しく 2 群に分け、その 1 群を使用した(development group)。残りの 1 群を、validation group として妥当性検証に用いた。上記スコアを用いると、discrimination 識別能は、development group で AUC=0.63, validation group で AUC=0.63 となった。モデルおよび実際のアウトカムによる予測値の較正能 calibration の評価を行うと、Hosmer-Lemshow tese P=0.38 であった。これらのことから構築モデルは現実に即したものであり、このスコアモデルの使用により健診時情報（検査＋問診項目）から、要受療レベル対象者のその後 1 年間の医療機関受療行動の予測（層別化）が可能となる。

T1:decision for potential predictive factors

factors		β coefficie	Scoring
Age	30-39 y.o.	-0.23	1
	40-49 y.o.	-0.10	2
	50-59 y.o.	0.11	3
	60-74 y.o.	0.23	4
women		0.08	1
血圧	(sBP≥140)	0.34	1
	(sBP≥160)	1.40	2
脂質	(LDL≥140)	0.10	1
	(LDL≥160)	0.97	2

血糖(HbA1c≧6.5)	1.08	1
(HbA1c≧8.4)	1.63	2
肝機能障害あり	0.25	1
生活習慣改善に取組んでいる	0.21	2
生活習慣を改善するつもり	0.12	1
保健指導を利用したい	0.06	1
就労あり（保険種別：本人）	-0.34	1
腹囲	0.09	1
自覚症状あり	0.10	1
体重増減±3kg/年以上あり	0.05	1
20 歳時比,体重 10kg 以上増加	0.06	1
食べるスピードが速い	0.16	2
食べるスピードが普通	0.06	1
就寝前に食事 and 朝食抜く	-0.06	1
上記でない（よい食習慣）	0.06	1
毎日飲酒する	-0.08	1
時々飲酒する	-0.08	1
睡眠で休養が十分とれている	0.04	1

【２】がんや難病と診断された就労患者の職場復帰（Fitness for Work）・就業継続（Stay at Work）支援を医療機関で推進するための基礎データの分析と実践に向けた取組み

275 名から回答を得た（回収率 25.0%）。回答者の 8 割以上は、職場復帰支援における連携の必要性を認めていた。連携が年 10 回未満である産業医を基準とし、年 10 回以上の連携のオッズ比(OR)を、事業場規模で調整したロジスティック回帰分析を行い算出した。復職および健診後事後措置時のそれぞれで、産業看護職の存在（各々OR 5.56(95%信頼区間：1.20-25.8)，5.01(1.37-18.3)）、主治医との情報交換様式の存在（各々4.21(2.01-8.82)，3.63(1.94-6.79)）、および連携に対する肯定的意識（各々 2.43(1.91-4.95)，2.04(1.14-3.65)）の影響は有意だった。これに対し、産業医個人の属性因子（経験年数、産業医の専門性、合わせて保持する臨床医の専門資格）の影響はいずれも有意ではなかった(p>0.05)。これらの結果は、職域、特に中小企業において職場復帰・就業継続支援をめざした実効性のある連携システムを整備すること、特に安価で簡便に導入可能な連携様式等のマニュアルを整備することの重要性を支持するものである。

がんや難病患者の両立支援を医療機関で推進するためには、医療多職種支援スタッフ(がん相談支援センターや難病相談センター等における看護師・薬剤師・臨床心理士・医療職両立支援コーディネータ）の役割が不可欠である。個別の診療科主治医が気づきにくい、診療科横断的だが職場での就業継続に負の影響を与えやすい症状に着目しフォローや必要に応じた主治医連携を図ることが求められる。このような invisible symptoms（他人に気づかれにくい症状）には、①体力低下や倦怠感・だるさ（cancer related fatigue）、②慢性疼痛（頭痛、腰痛、背部痛、四肢の痛み）、③メンタルヘルス不調や睡眠障害[9)10)]、④認知機能低下[11)]（集中力・記憶力低下）が挙げられる。今年度はまず医療機関において、特に診断後の就労継続、両立をめざす患者に支援窓口があることの周知体制の構築をめざし別図の flyer を作成した。

D. 考察

本年度の分析結果より、重症化予防の観点で、健診後の受療行動促進／抑制因子が明らかとなった。促進因子としては、高年齢・ハイリスク・3 疾病のなかでは血糖（糖尿）・生活習慣改善の行動期や関心期が挙げられた。問診各項目は、有意に正の促進因子であってもその大きさは小さいものが大半であったが、「食べるスピードが速い」ことは他項目と比較して有意に大きな促進因子であった。一般的に早食いは肥満等のリスクとされるが、受

療行動の観点では有利に働くことは興味深い結果である。促進効果は小さいが正にはたらくという結果となった、自覚症状あり・体重増加（変化）あり・腹囲基準該当以上等の項目は、「受療の必要性を本人が自覚」する要因として納得がいくものである。また同様に正の項目として、よい食習慣・睡眠で休養がとれている等は、生活に時間精神的な余裕がある場合に受療行動をとるという解釈が可能であろう。一方、負の因子（抑制）として抽出された就労・年齢が若いことは、影響効果が相対的に大きいことが浮き彫りとなった。性別は有意差はあるが、就労等と比べると大きさは小さく、性差よりも就労に伴う時間的制約等の方が行動に与える影響が大きいことが示唆された。また予想に反し、(腹囲とは異なり）BMI は促進・抑制双方に有意な影響はなく、喫煙や運動習慣も同様であった。本結果で構築ならびに妥当性を検証した予測モデルを活用して、対象者の層別化による保健指導と受療行動促進にむけた連携戦略を来年度以降実施する。

がんや難病と診断された患者の就労継続・職場復帰支援へむけた連携の分析と取組みとしては、先行研究の医療機関[1 2)]のみならず、職域でも支援体制のシステム整備が連携推進に寄与することが明らかとなった。特に安価で簡便に導入可能な連携様式等のマニュアルを整備することの重要性が示唆され、今後、ポータルサイトなどのプログラムやダウンロード式で、中小企業などでも簡便に活用できるモデル構築を図っていく。さらに医療機関でのがん相談支援センターや難病相談支援センター等での取組みは、「主治医による社会的処方（social prescribing）[3)]」のサポートを院内多職種チームで実施していくことで、特に産業保健スタッフ・リソースの活用が困難なことも多い中小企業勤務者・自営業者等に対する強力な empowerment となる。就労継続・職場復帰という治療と職業生活の両立について、薬剤の副作用と業務内容の調整・配慮項目等、各疾患別に取りまとめが進むツールを院内で効果的に活用できるシステム作りが急務である。本年度作成した flyer により、院内の患者目線の動線が支援部門に向かうことをめざし、来年度以降その取り組みの評価並びに、職域との連携モデル実践を図っていく。

Ｆ.健康危険情報

なし

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H. 知的財産権の出願・登録

特に記載するべきものなし

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Ⅲ. 研究成果の刊行に関する一覧

研究成果の刊行に関する一覧表

【H29.4.1～H30.3.31】

雑誌

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Ⅳ. 研究成果の刊行物・別刷

ORIGINAL ARTICLE

Development of the Japanese Version of the Leeds Assessment of the Neuropathic Symptoms and Signs Pain Scale: Diagnostic Utility in a Clinical Setting

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■ **Abstract**

Objective: We aimed to assess the diagnostic utility of the linguistically validated Japanese version of the Leeds Assessment of Neuropathic Symptoms and Signs Pain Scale (LANSS-J) as a screening tool for neuropathic pain in the clinical setting.

Methods: Patients with neuropathic pain or nociceptive pain who were 20 to 85 years of age were included. Sensitivity and specificity using the original cutoff value of 12 were assessed to evaluate the diagnostic utility of the LANSS-J. Sensitivity and specificity with possible cutoff values were calculated, along with area under the receiver operating characteristic curve. We then evaluated agreement regarding assessment of the LANSS-J by two investigators. We used the intraclass correlation coefficient (ICC) for the total score and Cohen's kappa coefficient for each item.

Results: Data for patients with neuropathic pain ($n = 30$) and those with nociceptive pain ($n = 29$) were analyzed. With a cutoff of 12, the sensitivity was 63.3% (19/30) and the specificity 93.1% (27/29). Sensitivity improved substantially with a cutoff of ≤ 11 ($\geq 83.3\%$, 25/30). High specificity (93.1%, 27/29) was sustained with a cutoff of 9 to 12. The ICC for the total score was 0.85, indicating sufficient agreement. Kappa coefficients ranged from 0.68 to 0.84.

Conclusions: The LANSS-J is a valid screening tool for detecting neuropathic pain. Our results suggest that

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employing the original cutoff value provides high specificity, although a lower cutoff value of 10 or 11 (with its high specificity maintained) may be more beneficial when pain attributed to neuropathic mechanisms is suspected in Japanese patients. ■

Key Words: neuropathic pain, Leeds Assessment of Neuropathic Symptoms and Signs Pain Scale, Japanese version, screening tools, diagnostic utility

INTRODUCTION

Neuropathic pain is defined as "pain caused by a lesion or disease of the somatosensory nervous system."[1] Neuropathic pain negatively affects physical functioning, emotional functioning (eg, depression, anxiety), sleep, and role and social functioning.[2] Unsurprisingly, health-related quality of life is lower in patients with chronic neuropathic pain than in those with chronic non-neuropathic pain.[3,4]

Although an appropriate diagnosis is essential for successful management of neuropathic pain, the diagnosis is challenging because neuropathic pain often coexists with other types of pain and symptoms.[5] Neuropathic pain mostly presents at and is managed in a primary care setting or in hospital clinics by nonspecialists.[6] Hence, a reliable, quick screening tool could help these nonspecialists identify patients with neuropathic pain.

The Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) Pain Scale was developed as a screening questionnaire to differentiate patients with neuropathic pain from those with nociceptive pain.[7] It consists of seven items: five items for assessing pain and two items for sensory examination. For pain assessment, clinicians interview patients with questions on dysesthesia, autonomic dysfunction, evoked pain, paroxysmal pain, and thermal pain. For the sensory examination, the clinician tests for the presence of allodynia and for an altered pinprick threshold (PPT). The total score (sum of the 7-item scores) ranges from 0 to 24 points. A total score of ≥ 12 indicates that neuropathic mechanisms are likely contributing to the patient's pain.[7]

The original English language version of the LANSS Pain Scale is known to have high diagnostic accuracy.[7,8] It has been translated and widely used in several languages, including Turkish, Spanish, Swedish, Chinese, and Brazilian Portuguese.[9–14] In a previous study, we translated the LANSS Pain Scale into Japanese (LANSS-J) and validated it linguistically, after obtaining development permission from the original developer, Dr. Michael I. Bennett.[15] Its diagnostic utility as a screening tool, however, has not yet been assessed. Therefore, in this study we evaluated the diagnostic utility of the LANSS-J to determine whether it can be used as a screening tool in the clinical setting in Japan.

METHODS

The study was approved by the Ethics Committee (an investigational review board) of the University of Tokyo in January 2015. Written informed consent was obtained from each eligible participant.

Participants

Patients with neuropathic pain or nociceptive pain who were 20 to 85 years of age were included in this study. Patients with neuropathic pain were included only if their chief complaint was diagnosed as pain of neuropathic origin, which included diabetic peripheral neuropathy, postherpetic neuralgia, trigeminal neuralgia, and postchemotherapy neuropathy. Patients with nociceptive pain were included only if their chief complaint was diagnosed as nociceptive pain, such as osteoarthritis of the knee or hip.

Patients with neuropathic pain were excluded if they had clear comorbidity-related nociceptive symptoms, including bruises or joint pain derived from osteoarthritis. Patients with nociceptive pain were excluded if they had clear comorbidity-related neuropathic symptoms such as that derived from diabetes under treatment, intervertebral disk herniation (positive straight leg raising test, $< 70°$), or lumbar spinal stenosis (positive Kemp test). Patients who had mixed pain, a psychiatric disorder, dementia, fever, or menstrual pain, those who were incapable of understanding and completing the questionnaires by themselves, and those who were deemed inappropriate for participation by the investigators were also excluded.

Data Collection

After ethical approval was obtained, participants were recruited from March through July 2015 at two departments of the University of Tokyo Hospital. Patients with neuropathic pain were recruited at the Department of Anesthesiology and Pain Relief Center and patients with nociceptive pain at the Department of Orthopaedic Surgery and Spinal Surgery.

The attending doctor (primary investigator) interviewed each patient to assess pain using the LANSS-J. The patient then completed two self-administered questionnaires: the Japanese version of the painDETECT questionnaire (PDQ-J) and the EuroQol 5 Dimension (EQ-5D). Another doctor (secondary investigator) then administered the same LANSS-J to the patient on the same day.

The primary investigator collected the demographic and clinical characteristics of each patient. For the original LANSS Pain Scale, the PPT was assessed using a 23-gauge needle. In this study, however, a partially extended paper clip (instead of the needle) was used to avoid injuring the skin.

The PDQ-J is a reliable, valid screening tool for identifying neuropathic pain. It was originally developed in Germany to detect neuropathic pain components in patients with chronic low back pain.[16] A total PDQ-J score ranges from 0 to 38. Scores of ≤ 12 indicate that it is unlikely that neuropathic pain is present. Scores of ≥ 19 indicate that it is highly likely that neuropathic pain is present.

The EQ-5D is a 5-item, self-administered questionnaire that provides a single index value for the general health status of the respondent.[17] The Japanese version of the EQ-5D has been widely used in research. The index score produced by conversion of the assessed health status ranges from −0.11 to 1.00. A score of 1 indicates "perfect health," and a score of 0 indicates "death."

Statistical Analysis

We performed descriptive analyses of demographic and clinical characteristics of patients. Summary statistics on age, sex, diagnosis, time since diagnosis, body mass index (BMI), PDQ-J score, and EQ-5D score were calculated for patients with neuropathic pain and those with nociceptive pain.

The sensitivity and specificity of the LANSS-J were assessed using data collected by the primary investigators to evaluate its diagnostic utility. The scoring method of the original LANSS Pain Scale was utilized. Using the same cutoff value as for the original LANSS Pain Scale, the sensitivity and specificity of the LANSS-J were computed. Sensitivity was the percentage of patients with a LANSS-J score of ≥ 12 among those with a diagnosis of neuropathic pain. Specificity was the percentage of patients with a LANSS-J score of < 12 among those with a diagnosis of nociceptive pain, along with the area under the receiver operating characteristic curve (AUC). To assess changes in the screening results of the LANSS-J that depended on a cutoff value, we calculated the sensitivity and specificity with possible cutoff values and AUCs.

Subsequently, the intraclass correlation coefficient (ICC) value for the LANSS-J total score was calculated to evaluate agreement of the assessments by the primary and secondary investigators using data collected on the same day. In addition, Cohen's kappa was calculated for each item to assess agreement of the assessments by investigators. An ICC of ≥ 0.7 was considered the minimum required.[18] The kappa coefficients were interpreted according to the following criteria: poor, < 0.20; fair, 0.21 to 0.40; moderate, 0.41 to 0.60; good, 0.61 to 0.80; and very good, 0.81 to 1.00.[19,20]

All of the statistical tests were 2-sided, with a significance level of 0.05. All analyses were performed using SAS software version 9.3 (SAS Institute, Inc. Cary, NC, USA).

RESULTS

A total of 60 patients were included in the study. Among them, one patient had missing responses to the LANSS-J. Therefore, our final study group was composed of 59 patients (Figure 1). In all, 30 patients (50.8%) were diagnosed with neuropathic pain and 29 patients (49.2%) with nociceptive pain while waiting for knee or hip replacement surgery. Demographic and clinical characteristics of the patients are summarized by pain type in Table 1. The neuropathic pain patients were younger, included more men, had a longer interval since diagnosis, and had a higher average PDQ-J score than the nociceptive pain group. BMI did not differ greatly between the two groups. Detailed etiologies of the diagnoses are shown in Table 2.

Employing the cutoff value of 12, as suggested by the original developer, the sensitivity of the LANSS-J for diagnosing neuropathic pain was 63.3% (19/30), and the specificity of the scale for diagnosing nociceptive pain was 93.1% (27/29) (Table 3). The AUC for the cutoff value was 0.782.

Table 3 shows the sensitivity, specificity, and AUC for each possible LANSS-J cutoff value. The sensitivity of the scale substantially improved with a cutoff value of 11 (83.3%, 25/30), whereas the specificity was unchanged using cutoff values of 12 descending to 9 (93.1%, 27/29).

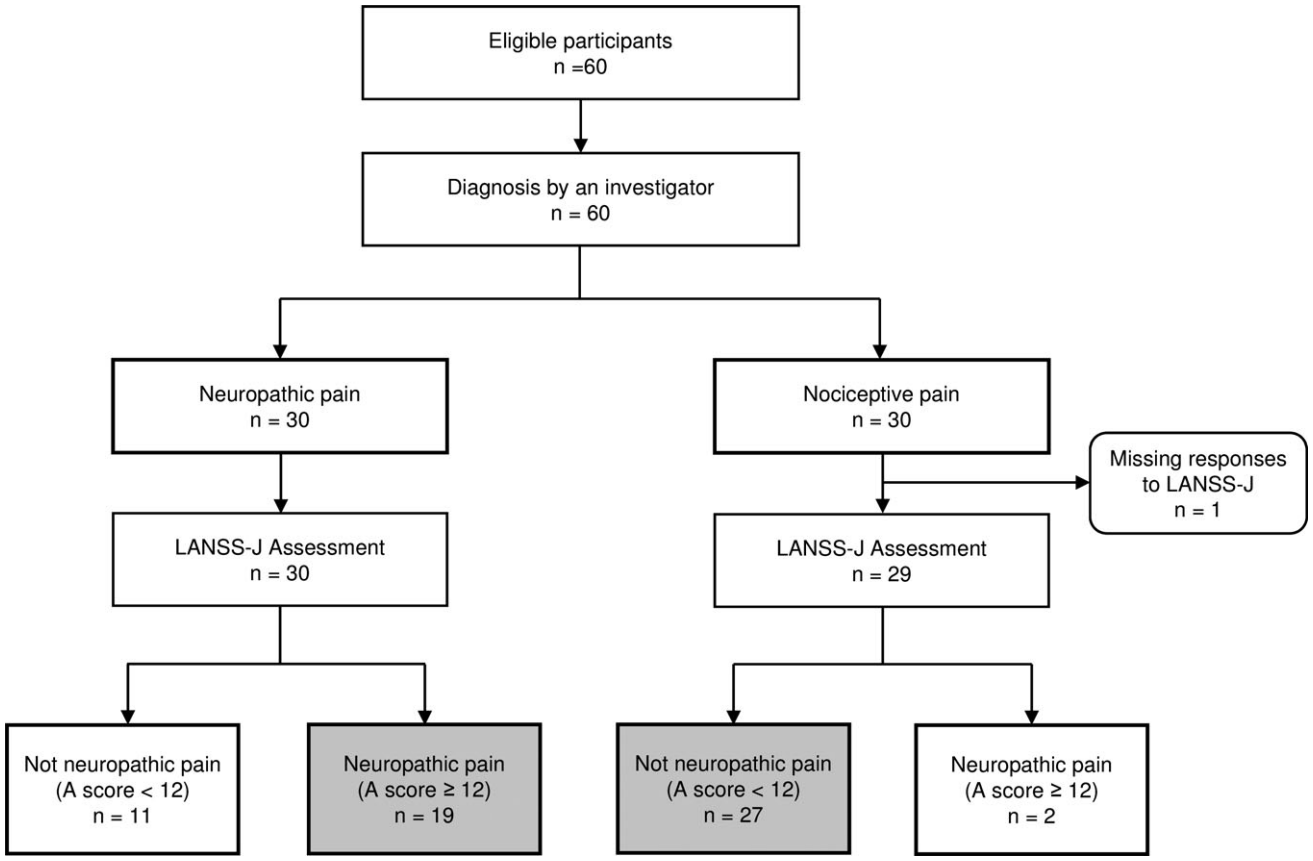

Figure 1. Flow diagram of participants in the study. The diagnostic flow diagram shows the case when using a cutoff value of 12 for the Japanese version of the Leeds Assessment of Neuropathic Symptoms and Signs Pain Scale (LANSS-J). A LANSS-J score of ≥ 12 indicates the probable pain originating from neuropathic mechanisms. A score of < 12 indicates the probable pain not originating from neuropathic mechanisms.

Table 1. Demographic and Clinical Characteristics of Participants, by Pain Type

Characteristics	Neuropathic Pain Group (*n* = 30)	Nociceptive Pain Group (*n* = 29)
Mean years of age (SD)	56.4 (12.9)	70.5 (8.6)
Female, *n* (%)	10 (33.3)	26 (89.7)
Mean months since diagnosis (SD)	94.4 (89.9)	67.6 (50.8)
Mean BMI (kg/m^2) (SD)	23.2 (3.7)	25.0 (4.1)
Mean PDQ-J score (SD)	18.1 (5.4)	5.0 (5.6)
Mean EQ-5D score (SD)	0.4 (0.3)	0.6 (0.1)

BMI, body mass index, PDQ-J, Japanese version of the painDETECT Questionnaire; EQ-5D, EuroQol 5 Dimension.

Agreement of the Assessments by Investigators

Agreement in the assessment of the LANSS-J by the primary and secondary investigators was reflected in an ICC of 0.85 using data from 51 patients (28 neuropathic pain patients, 23 nociceptive pain patients) in whom the assessments were conducted on the same day. The kappa coefficient for agreement between investigators for individual items was 0.71 for dysesthesia, 0.84 for autonomic dysfunction, 0.69 for evoked pain, 0.76 for paroxysmal pain, 0.80 for thermal pain, 0.68 for allodynia, and 0.80 for altered PPT.

DISCUSSION

We assessed the diagnostic utility of the LANSS-J using data collected from Japanese patients with neuropathic or nociceptive pain. The results suggest that the LANSS-J had debatable sensitivity when it employed the cutoff value used for the original LANSS Pain Scale but good specificity and agreement of the assessments.

The sensitivity using the original cutoff value was lower (63.3%) than that for the original LANSS (85.0%) or for LANSS versions in other languages (80.0% to 89.9%), whereas the specificity was higher (93.1%) than that for the original LANSS (80.0%) and Spanish LANSS (89.4%) but lower than for the Turkish (94.2%) and Chinese (97.1%) versions.[7,9,10,12] The

Table 2. Etiology of Patients' Diagnoses

Etiology	Neuropathic Pain Group (n = 30)	Nociceptive Pain Group (n = 29)
Complex regional pain syndrome II	1	
Failed back surgery syndrome	5	
Diabetic polyneuropathy	1	
Chemotherapy-induced neuropathy	1	
Traumatic radial nerve injuries	1	
Syringomyelia	1	
Cervical spondylotic myelopathy	2	
Cervical spondylotic radiculopathy	1	
Cervical radiculopathy	1	
Vascular polyneuropathy	1	
Phantom limb pain	1	
Thalamic pain	3	
Spinal cord injuries induced by metastatic tumor	1	
Diabetic neuropathy	1	
Postoperative neuropathy (mammary gland)	1	
Brachial plexus injury	7	
Brachial plexus palsy	1	
Knee osteoarthritis		15
Hip osteoarthritis		14

Table 3. Sensitivity and Specificity of Possible Cutoff Values with the AUC

Cutoff Value	Sensitivity % (n/N Patients)	Specificity % (n/N Patients)	AUC
≥ 0	100 (30/30)	0 (0/29)	0.500
≥ 3	100 (30/30)	65.5 (19/29)	0.828
≥ 6	100 (30/30)	72.4 (21/29)	0.862
≥ 9	90.0 (27/30)	93.1 (27/29)	0.916
≥ 10	86.7 (26/30)	93.1 (27/29)	0.899
≥ 11	83.3 (25/30)	93.1 (27/29)	0.882
≥ 12	63.3 (19/30)	93.1 (27/29)	0.782
≥ 13	63.3 (19/30)	93.1 (27/29)	0.782
≥ 14	63.3 (19/30)	93.1 (27/29)	0.782
≥ 15	60.0 (18/30)	93.1 (27/29)	0.766
≥ 18	46.7 (14/30)	96.6 (28/29)	0.716
≥ 21	16.7 (5/30)	96.6 (28/29)	0.566

AUC, area under the receiver operating characteristic curve.

sensitivity was lower in the present study probably because patients with severe traumatic nerve injury were included in the neuropathic pain group. Because of the severe nerve damage in these patients, evoked pain and allodynia could barely be perceived. In fact, among the 30 patients, 15 and 17 patients provided a negative response to the descriptors of evoked pain and allodynia, respectively. Traumatic nerve injury does not entail changes in the color of the skin attributable to impaired blood flow or hyperpigmentation, unlike diabetic

Table 4. Agreement of LANSS-J Assessments Between the Two Investigators, by Cutoff Values

Cutoff Value	Kappa	No. of Patients Correctly Identified by the LANSS-J in Two Assessments: Neuropathic Pain (n = 28)	Nociceptive Pain (n = 23)
≥ 12	0.65	17	21
≥ 11	0.80	23	21
≥ 10	0.84	24	21

Cohen's kappa coefficients were computed to evaluate the agreement in screening results (either neuropathic or non-neuropathic pain) between the two assessments based on the LANSS-J total scores for a cutoff value of 12, 11, and 10.
LANSS-J, Japanese version of the Leeds Assessment of Neuropathic Symptoms and Signs Pain Scale.

neuropathy and postherpetic neuralgia. Among the 30 patients in the neuropathic pain group, 17 reported a negative response to the descriptors of autonomic dysfunctions. It is legitimate that a score of evoked pain in the PDQ-J was also low in the neuropathic pain group —the third lowest score in seven pain categories—but as low as the second lowest pain caused by slight pressure. Hence, lower scores for evoked pain, allodynia, and autonomic dysfunction in patients with neuropathic pain presumably resulted in the lower sensitivity.

Another possible explanation for the lower sensitivity is that the patients did not openly express their feelings about the pain they felt. In traditional Japanese culture, stoicism and the desire to conceal pain and emotions are expected—unlike in European and American cultures, where expressing personal feelings is encouraged.[21]

The sensitivity was lower when using the original cutoff value of 12, whereas specificity was favorable. Exploration of a possible cutoff value shows that using a value of 10 or 11 alone improved sensitivity while leaving the specificity unchanged (sensitivity 86.7% and 83.3%, respectively; specificity 93.1% for both values; AUC 0.899 and 0.882, respectively). Given that the lower sensitivity in the LANSS-J, compared with that of the LANSS in other languages, results not only from the number of patients with traumatic nerve injuries included in the present study but also from cultural influences on their verbal expression, physicians conducting screening should suspect neuropathic components in the pain in patients whose LANSS-J score is 10 or 11.

For agreement of the LANSS-J assessments by two investigators, the ICC for the total LANSS-J score exceeded the sufficient level of 0.7.[22] The Spanish and Brazilian Portuguese versions indicated relatively higher ICCs (0.92 and 0.97, respectively) than were seen in the present results.[10,13] Regarding individual items, the

kappa coefficients, ranging from 0.68 for allodynia to 0.84 for autonomic dysfunction, indicated good to very good levels of agreement,[19] which is equivalent to the results of the original LANSS Pain Scale (0.6 for dysesthesia, 0.88 for autonomic dysfunction).[7] When looking at the ICCs in each pain group, however, compared with the ICC in the neuropathic pain group, the ICC in the nociceptive pain group was lower (0.81 vs. 0.22). Therefore, we further evaluated whether score changes between the two assessments resulted in a change in the screening results by the LANSS-J or if the LANSS-J screening results remained the same for the two assessments. The results were presented in Table 4. When employing the original cutoff value of 12, the kappa coefficient was 0.65, which is regarded as a good level, with 17 of 28 patients in the neuropathic pain group remaining positive, whereas 21 of 23 patients in the nociceptive pain group remained negative.

The results of further examinations depended on the cutoff point employed. The results suggest that a lower cutoff value may be more helpful for detecting neuropathic pain in a Japanese population. Similarly, a lower cutoff value yielded a higher kappa coefficient at the almost very good level or very good level. In contrast, the number of patients in the nociceptive pain group who remained negative stayed consistent: 0.80 for the cutoff value of 11 and 0.84 for the cutoff value of 10. When using the original cutoff value, the kappa coefficient was at the same level as with the original LANSS (0.65),[7] although higher kappa coefficients were observed in the Turkish (0.84) and Spanish (0.70) LANSS versions.[9,10] Regardless of the lower ICC in the nociceptive pain group, there was a good level of agreement of the LANSS-J screening results between the two assessments. Thus, the diagnostic utility with regard to agreement in the LANSS-J screening results was determined to be reasonably good. A large sample size, however, is needed for further assessment.

There are several limitations in the present study. First, generalization of the results of the present study is limited due to the relatively small sample size collected at a single institution. We prioritized patient recruitment with accurate diagnosis, and its feasibility as accurate diagnosis is essential in diagnostic utility. Thus, the findings should be considered exploratory in nature due to the limited number of the sample size. Our sample size may have resulted in lower sensitivity using the original cutoff value of 12. However, it should be kept in mind that the result may have resulted from the inclusion of patients with severe traumatic nerve injury in the sample. In addition, recruitment was conducted in a university hospital setting. As patients visiting a university hospital may differ from those receiving nonspecialized primary care, a particular group of patients were underrepresented. Further investigations with a large sample in various settings may be needed for more generic features of the LANSS-J, especially for nonspecialized primary care settings. For these limitations on generalizability, results need to be interpreted with care. Second, patients with neuropathic pain and those with nociceptive pain were recruited separately from the Department of Anesthesiology and Pain Relief Center and the Department of Orthopaedic Surgery and Spinal Surgery for feasibility reasons. Although the investigators administered LANSS-J in an interview format, the fact that not a single investigator assessed patients with both types of pain might have influenced the results to some extent. Results may differ if the LANSS-J is administered to patients experiencing pain of unknown origin at a nonspecialist, primary care level. Third, a partially stretched out paper clip was used to test for altered PPT to avoid skin cuts and bleeding because concerns were raised about using a 23-gauge needle for the pinprick (as the original LANSS Pain Scale instructed).[23] Patients' responses toward an altered PPT may differ if a needle were utilized in the present study (although pinprick has been commonly performed with a paper clip as an alternative method worldwide). Finally, to evaluate agreement in the LANSS-J assessments, we included only data that were obtained on the same day to retain the same evaluation time period in "as stable a condition as possible" by the primary and secondary investigators deemed to be equally capable of assessing patient conditions. It should be noted, however, that conducting the same-day assessment of the LANSS-J may not guarantee the same conditions for the two assessments regardless of a good level of agreement in the LANSS-J screening results based on kappa coefficients in patients whose assessments were conducted on the same day.

CONCLUSION

The present study indicated a sufficient level of diagnostic utility for the LANSS-J, demonstrating that the Japanese version of the LANSS Pain Scale is a valid screening tool for detecting pain originating from a neuropathic mechanism. The results suggest that employing the original cutoff value of 12 provides high specificity, allowing it to filter out patients with

non-neuropathic pain. A lower cutoff value of 11 or 10 (which maintains the high specificity) may be more beneficial when evaluating Japanese patients whose pain was suspected to be caused by a neuropathic mechanism.

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ORIGINAL RESEARCH

The relationship between findings on magnetic resonance imaging and previous history of low back pain

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Abstract: The objective of this study was to evaluate the relationship between magnetic resonance imaging (MRI) findings and previous low back pain (LBP) in participants without current LBP. Current LBP was defined as LBP during the past month. Previous LBP was defined as a history of medical consultation for LBP. Ninety-one participants without current LBP were included. Sagittal T2-weighted MRI was used to assess the intervertebral space from T12/L1 to L5/S1. These images were classified into five grades based on the Pfirrmann grading system. Furthermore, we evaluated the presence of disk bulging, high-intensity zone, and spondylolisthesis. We compared the MRI findings between groups with (27 participants) and without (64 participants) previous LBP without current LBP. Intraobserver and interobserver kappa values were evaluated. Participants had an average age of 34.9 years; 47 were female and 44 were male; and their average body mass index was 21.8 kg/m^2. Compared to the group of participants without previous LBP, the group of participants with previous LBP had a significantly higher incidence of disk degeneration such as a Pfirrmann grade ≥3, disk bulging, and high-intensity zone in the analyses adjusted by age and sex. There were no significant differences in spondylolisthesis between the groups. An odds ratio of >10 was only found for Pfirrmann grade ≥3, ie, a Pfirrmann grade ≥3 was strongly associated with a history of previous LBP in participants without current LBP.

Keywords: disk bulging, low back pain, magnetic resonance imaging, MRI, Pfirrmann grading, previous history, high-intensity zone

Introduction

Low back pain (LBP) affects most adults at some point in their lives. Approximately 85%–90% of cases are classified as nonspecific LBP.[1] In the last decade, LBP was continuously found to be the top leading cause of years lived with disability globally.[2] Similarly, in Japan, LBP is one of the most common causes of health disability, as in other industrialized countries, with a reported lifetime prevalence of >80%.[3] Especially in the workplace, LBP is an important and costly medical problem that leads to decreased employee health and productivity.[4]

Magnetic resonance imaging (MRI) can identify underlying pathologies of LBP. However, the importance of MRI findings is unclear and controversial. Some reports have shown that disk degeneration was associated with LBP,[5–7] while others have shown that there was no relationship between disk degeneration and LBP.[8,9] Although these reports focused on the relationship between disk degeneration and current LBP, there are a few reports on the relationship between MRI findings, including disk degeneration

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and previous LBP.[5,10] It has been suggested that symptoms of chronic LBP are often fluctuating, and this is a condition with a pattern of exacerbation and remission.[11] Some individuals have chronic LBP, whereas others have intermittent pain. We anticipate that if physicians know about the predictive MRI findings of recurrent severe LBP, we can selectively educate patients about preventing LBP. Therefore, we hypothesized that people whose lumbar MRI showed disk degeneration would be prone to developing severe LBP, unless they did not have current severe LBP. The purpose of this study was to evaluate the relationship between MRI findings and previous LBP symptoms in participants without current LBP.

Materials and methods

Study participants

From September 2005 to March 2006, we recruited volunteers who were personnel at Kanto Rosai Hospital to participate in the study. Ninety-one participants without current LBP were included. We administered a questionnaire to determine whether they had previous LBP symptoms. According to previous reports, current LBP was defined as pain localized between the costal margin and the inferior gluteal folds depicted in a diagram with or without lower extremity pain in the past 1 month.[1,12] The area was shown diagrammatically on the questionnaire according to a previous study.[12] Previous LBP was defined as a history of medical consultation for LBP. Medical consultation for LBP is one of the standards for evaluating the severity of LBP.[13] This indicated that the LBP was not mild. Then, we classified the participants into two groups, those with previous LBP and those without previous LBP. The study was approved by the review board of the Minister of Labor, Health, and Welfare of Japan. Written informed consent was obtained from all individual participants included in the study.

Image assessment

MRI was performed using a 1.5 T Siemens Symphony scanner (Siemens Healthcare, Erlangen, Germany). The imaging protocol included sagittal T2-weighted fast spin echo (repetition time: 3,500 ms/echo, echo time: 120 ms, and field of view: 300 × 320 mm). Sagittal T2-weighted images were used to assess the intervertebral space from T12/L1 to L5/S1. Assessment of the MRI scans was performed by an orthopedist (J.T.) who was blinded to the participants' backgrounds. We evaluated the degree of disk degeneration, disk bulging, the high-intensity zone (HIZ), and spondylolisthesis at each level of the spine. The degree of disk degeneration on MRI was classified into five grades based on the Pfirrmann classification system.[14] In the analysis, we divided Pfirrmann grading into two categories, grades 1–2 and grades 3–5. Disk bulging was defined as displacement of the disk material, usually by >50% of the disk circumference and <3 mm beyond the edges of the disk space in the axial plane.[15] As we were only able to evaluate the sagittal planes of MRI scans, we defined disk bulging as posterior disk displacement <3 mm and equivalent to the anterior disk displacement in the sagittal plane. We defined HIZ as an area of brightness or high signal intensity located in the posterior annulus on T2-weighted images based on previous literature.[16] We defined spondylolisthesis as vertebral slips of >5 mm. To evaluate intraobserver variability, 20 randomly selected MRI scans of the lumbar spine were rescored by the same observer (J.T.) >1 month after the first reading. Furthermore, to evaluate interobserver variability, 20 other MRI scans were scored by two orthopedists (J.T. and A.H.) using the same classification.

Finally, we focused on comparing the relationship between the MRI findings and previous LBP.

Statistical analysis

The kappa statistic was used to summarize the intrareader and interreader reliability of the ratings. The kappa statistics were calculated with linear weights to give less importance to disagreements closer together on an ordinal scale. The schema of Landis and Koch[17] was used to interpret the strength of agreement based on the following values: 0, poor; 0–0.20, slight; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.80, substantial; and 0.81–1.00, almost perfect. Between-group differences in baseline characteristics were evaluated using the Fisher's exact test for categorical variables and the Student's *t*-test for continuous variables. We compared the MRI findings between groups with and without previous LBP that did not have current LBP by using the Fisher's exact test. Furthermore, we determined the odds ratios of each item using univariate analyses and adjusting the analyses by age and sex. The statistical analyses were performed using the JMP 11.0 software program (SAS Institute, Cary, NC, USA). A p-value of <0.05 was considered to be significant.

Results

Of 91 participants, 27 had a history of LBP, which was indicated during medical consultation. The remaining 64 participants did not have any history of LBP. Participants' average age was 34.9 ± 10.6 years; 47 were female and 44 were male; and their average body mass index (BMI) was 21.8 ± 3.0 kg/m^2. The average ages of those who did and did

Table 1 Demographic data of the participants

Backgrounds	Total, n = 91	Previous LBP (+) group, n = 27	Previous LBP (–) group, n = 64	*p*-value
Age (years)	34.9 ± 10.6	38.3 ± 10.7	33.5 ± 10.4	0.0486*
Sex				
Female	47	12 (25.5)	35 (74.5)	0.3718
Male	44	15 (34.1)	29 (65.9)	
BMI (kg/m^2)	21.8 ± 3.0	21.8 ± 0.6	21.7 ± 0.4	0.9639

Notes: Data are shown as mean ± standard deviation or the number of participants (%). *$p < 0.05$.
Abbreviations: –, negative; +, positive; LBP, low back pain; BMI, body mass index.

Table 2 Details of the intraobserver and interobserver reliability of Pfirrmann grading, disk bulging, the high-intensity zone, and spondylolisthesis on magnetic resonance imaging reading

MRI findings	MRI (n)	Kappa	95% CI
Pfirrmann grading			
Intraobserver reliability	20 vs 20	0.66	0.55–0.77
Interobserver reliability	20 vs 20	0.64	0.52–0.76
Disk bulging			
Intraobserver reliability	20 vs 20	0.60	0.39–0.81
Interobserver reliability	20 vs 20	0.67	0.48–0.87
High-intensity zone			
Intraobserver reliability	20 vs 20	0.85	0.64–1.06
Interobserver reliability	20 vs 20	0.93	0.79–1.07
Spondylolisthesis			
Intraobserver reliability	20 vs 20	NA	NA
Interobserver reliability	20 vs 20	NA	NA

Abbreviations: CI, confidence interval; MRI, magnetic resonance imaging; NA, not applicable.

Table 3 Magnetic resonance imaging findings at any spinal level in groups with and without previous LBP that did not have current LBP

MRI findings	Total, n = 91	Previous LBP (+) group, n = 27	Previous LBP (–) group, n = 64	*p*-value
Pfirrmann grade ≥3	69 (75.8)	26 (96.3)	43 (67.2)	0.0026*
Disk bulging +	48 (52.3)	21 (77.8)	27 (42.2)	0.0019*
High-intensity zone +	19 (20.9)	9 (33.3)	10 (15.6)	0.0883
Spondylolisthesis +	4 (4.4)	3 (11.1)	1 (1.6)	0.0766

Notes: Data are shown as the number of participants (%). *$p < 0.05$.
Abbreviations: –, negative; +, positive; LBP, low back pain; MRI, magnetic resonance imaging.

not have a history of LBP were 38.3 and 33.5 years, respectively, which were significantly different ($p = 0.0486$). There were no significant differences in sex and BMI between the groups (Table 1).

The intraobserver and interobserver variabilities for Pfirrmann grading on MRI were 0.66 and 0.64, respectively. Those for disk bulging were 0.60 and 0.67, respectively. Those for the HIZ were 0.85 and 0.93, respectively. In 20 randomly selected MRIs, one observer did not identify spondylolisthesis at all, while the other observer identified spondylolisthesis in two levels of one participant. Thus, the intraobserver and interobserver variabilities for spondylolisthesis could not be calculated (Table 2).

Compared to the group without previous LBP, the group with previous LBP had a significantly higher incidence of disk degeneration such as a Pfirrmann grade ≥3 in at least one spinal level ($p = 0.0026$). In addition, the group with previous LBP had a significantly higher incidence of disk bulging in at least one spinal level than the group without previous LBP ($p = 0.0019$). There were no significant differences in HIZ ($p = 0.0883$) and spondylolisthesis ($p = 0.0766$) between the two groups according to the results of the Fisher's exact test (Table 3). Regarding the findings for each spinal level, compared to the group without previous LBP, the group with previous LBP had a significantly higher incidence of disk degeneration such as a Pfirrmann grade ≥3 at the T12/L1 ($p = 0.0350$), L3/4 ($p = 0.0232$), L4/5 ($p = 0.0005$), and L5/S1 ($p = 0.0026$) levels; and disk bulging at the L2/3 ($p = 0.0277$), L3/4 ($p = 0.0113$), L4/5 ($p = 0.0018$), and L5/S1 levels ($p = 0.0081$; Table 4). The findings of HIZ were almost all observed at the L4/5 and L5/S1 levels. Spondylolisthesis was only observed at the L4/5 and L5/S1 levels. In univariate analyses, the odds ratios of a Pfirrmann grade ≥3, disk bulging, HIZ, and spondylolisthesis were 12.7, 4.8, 2.7, and 7.9, respectively. There were significant differences for a Pfirrmann grade ≥3 ($p = 0.0009$) and disk bulging ($p = 0.0015$) in univariate analyses. In the adjusted analyses by age and sex, the odds ratios of the aforementioned four items were 10.5, 4.2, 3.1, and 6.6, respectively, and there were significant differences for a Pfirrmann grade ≥3 ($p = 0.0065$), disk bulging ($p = 0.0047$), and HIZ ($p = 0.0405$; Table 5).

Discussion

Among the participants in this study, ~30% had previous LBP, which was determined during the medical consultation. As in many industrialized countries, LBP is one of the most common health disabilities in Japan. In a population-based

Table 4 Pfirrmann grade and disk bulging at each spinal level in groups with and without previous LBP that did not have current LBP

MRI findings	Level	Total, n = 91	Previous LBP (+) group, n = 27	Previous LBP (–) group, n = 64	*p*-value
Pfirrmann grade ≥3	T12/L1	18 (19.8)	9 (33.3)	9 (14.1)	0.0350*
	L1/2	22 (24.2)	9 (33.3)	13 (20.3)	0.1851
	L2/3	30 (33.0)	10 (37.0)	20 (31.3)	0.5917
	L3/4	44 (48.4)	18 (66.7)	26 (40.6)	0.0232*
	L4/5	56 (61.5)	24 (88.9)	32 (50.0)	0.0005*
	L5/S1	56 (61.5)	23 (85.2)	33 (51.6)	0.0026*
Disk bulging (+)	T12/L1	2 (2.2)	1 (3.7)	1 (1.6)	0.5245
	L1/2	1 (1.1)	1 (3.7)	0 (0.0)	0.1216
	L2/3	2 (2.2)	2 (7.4)	0 (0.0)	0.0277*
	L3/4	5 (5.5)	4 (14.8)	1 (1.6)	0.0113*
	L4/5	35 (38.5)	17 (63.0)	18 (28.1)	0.0018*
	L5/S1	35 (38.5)	16 (59.3)	19 (29.7)	0.0081*

Notes: Data are shown as the number of participants (%). *$p < 0.05$.
Abbreviations: –, negative; +, positive; LBP, low back pain; MRI, magnetic resonance imaging.

Table 5 Odds ratio, 95% CI, and *p*-value from univariate analyses and analyses adjusted by age and sex for magnetic resonance imaging findings of groups with and without previous LBP that did not have current LBP

MRI findings	Univariate analyses			Age-adjusted and sex-adjusted analyses		
	Odds ratio	95% CI	*p*-value	Odds ratio	95% CI	*p*-value
Pfirrmann grade ≥3	12.7	2.43–234.18	0.0009*	10.5	1.78–202.09	0.0065*
Disk bulging	4.8	1.79–14.55	0.0015*	4.2	1.54–13.15	0.0047*
High-intensity zone	2.7	0.94–7.78	0.0652	3.1	1.05–9.42	0.0405*
Spondylolisthesis	7.9	0.96–163.50	0.0551	6.6	0.74–141.71	0.0923

Note: *$p < 0.05$.
Abbreviations: CI, confidence interval; LBP, low back pain; MRI, magnetic resonance imaging.

survey, the lifetime and 4-week LBP prevalence was 83% and 36%, respectively.[3] Therefore, LBP is one of the common causes of disability. In the current study, we precisely defined the region of LBP, which seemed to be important for standardizing the study protocol for LBP.[1,12] We also defined previous LBP as a history of medical consultation for LBP, which can exclude mild previous LBP. There was a significant difference in age between the two groups. Considering that disk degeneration progresses with advancing age,[6] the analyses performed in our study can be considered as appropriate.

The intraobserver and interobserver variabilities for each MRI finding were greater than moderate for all evaluated items.

MRI findings consistent with Pfirrmann grade ≥3, especially at the lower lumbar disk level, disk bulging, and HIZ were associated with previous LBP. Spondylolisthesis was not associated with previous LBP. There were significant differences between the groups in terms of a Pfirrmann grade ≥3, disk bulging, and HIZ according to the analyses adjusted by age and sex. The odds ratio of only the Pfirrmann grade ≥3 was >10, ie, a Pfirrmann grade ≥3 is strongly associated with a history of previous LBP in those without current LBP.

Pfirrmann grading indicates the degree of disk degeneration.[14] We divided the grading into two groups for the purpose of analysis. We regarded those with grades 1–2 as having no or little disk degeneration and those with grades 3–5 as having some degree of disk degeneration. There have been many reports on the relationship between current LBP and disk degeneration;[5–7] however, none have reported on the relationship between previous LBP and Pfirrmann grading. Videman et al[10] showed that disk height narrowing was associated with previous LBP, but they did not use Pfirrmann grading. Since disk height narrowing was classified as Pfirrmann grade 5,[14] this can be interpreted as implying that severe disk degeneration was associated with previous LBP. Although we included Pfirrmann grades 5, 3, and 4, which did not indicate severe disk height narrowing, our findings were almost consistent with the previous study's findings in terms of disk degeneration.

Pfirrmann grade ≥3 at T12/L1, L3/4, L4/5, and L5/S1 was associated with previous LBP. A large population study showed that disk degeneration was most commonly affected at L5-S1 and L4-L5,[6] which corresponds with our findings. A mechanical study showed that the range of motion in the

lower lumbar segments was significantly smaller than that in the upper segments.[18] The small range of motion at the intervertebral disk space can cause the load to increase at the disk, which can easily cause disk degeneration. This may be a reason why disk degeneration was more prominent at the lower lumbar disk levels than at the upper disk levels in the current study.

Disk bulging was associated with previous LBP. Regarding each spinal level, disk bulging at the L2/3, L3/4, L4/5, and L5/S1 levels was associated with previous LBP. Although the *p*-values were inclined to be smaller at lower disk levels than at upper disk levels, previous LBP was associated with disk bulging at almost all the lumbar disk levels. Some studies have shown that disk bulging was frequently observed in asymptomatic subjects, and it was concluded that there was no relationship between disk bulging and current LBP,[19,20] whereas another study of a meta-analysis showed a strong relationship.[7] As for previous LBP, Videman et al[10] showed that disk bulging was not associated with previous LBP. Our findings were not consistent with previous findings in terms of disk bulging.

A systematic review of the relationship between MRI findings and current LBP showed that disk degeneration and disk bulging are associated with current LBP, especially in younger adults, and this relationship disappears in older populations.[7] Although the study did not mention previous LBP, we can assume that older adults with disk degeneration or disk bulging who do not have current LBP may have had LBP when they were younger. These results correspond with our findings.

The HIZ was often observed at the level of L4/5 and L5/S1, and it was associated with previous LBP. There was a significant difference in the analyses adjusted by age and sex ($p = 0.0405$), although no significant relationship was found using the Fisher's exact test and univariate analyses. Aprill and Bogduk[16] reported a strong correlation between the annular high signal intensity zone and positive provocative discography. Some study has shown that the HIZ was associated with current LBP.[21] Dongfeng et al[22] performed a histological study on excised disks with a HIZ, and they concluded that the HIZ may be a specific signal for the inflammatory reaction of a painful disk. Conversely, other studies have shown that the HIZ was frequently observed in asymptomatic subjects.[7,19,20] As for previous LBP, Videman et al[10] showed that annular tear on axial MRI scans was associated with previous LBP. However, there has been no report on the relationship between the HIZ and previous LBP.

Spondylolisthesis was considered to be one of the findings of lumbar spine instability.[23] Considering that instability of the lumbar spine can cause LBP, it was assumed that those who had spondylolisthesis were inclined to have LBP.[24] However, some reports identified no significant relationship between spondylolisthesis and current LBP.[7,25] Furthermore, Hasegawa et al[26] showed that the radiological findings of spondylolisthesis cannot indicate instability. However, there has been no report on the relationship between spondylolisthesis and previous LBP. In our study, only four participants who did not have current LBP had spondylolisthesis. Three of these had previous LBP, and only one did not have previous LBP. There was no significant relationship between spondylolisthesis and previous LBP; however, this may be attributed to the small number of spondylolisthesis cases in our study.

One systematic review showed that HIZ and spondylolisthesis are not associated with current LBP, even in younger adults.[7] Therefore, the aforementioned information about disk degeneration or disk bulging does not correspond with HIZ and spondylolisthesis.

While some chronic LBP patients show continuous pattern, others have intermittent pattern.[11] Therefore, there was a possibility that the participants in our study who had previous LBP without current LBP had chronic LBP as intermittent pain. They did not have LBP at the time of participation; however, they may suffer recurrent LBP in the future as a natural course in the intermittent LBP pattern. Based on the results of the current study, MRI findings consistent with Pfirrmann grade ≥3, disk bulging, and HIZ may be one of the predictive signs of recurrent severe LBP. Thus, we can selectively educate patients about preventing LBP.

There were some limitations to the current study. First, we did not evaluate end plate changes because we only analyzed sagittal T2-weighted images and T1-weighted images were unavailable, even though Modic change has been considered to be associated with LBP.[5] In a population-based study on 975 participants, Teraguchi et al[27] showed that the combination of disk degeneration and end plate changes was highly associated with current LBP, whereas disk degeneration alone was not associated with current LBP. There is no previous report on the relationship between end plate changes and previous LBP, and we did not assess this relationship in our study. Second, we only analyzed sagittal images. Disk bulging and the HIZ can sometimes be visible at the posterolateral sides; however, these can be underestimated. Third, there was selection bias among our study participants, as they were volunteers from all types of employment at the hospital and did not represent the general population.

Conclusion

MRI findings consistent with Pfirrmann grading ≥3, especially at the lower lumbar disk level, disk bulging, and HIZ

were associated with previous LBP. In addition, spondylolisthesis was not associated with previous LBP. These findings may be one of the predictive signs of recurrent severe LBP.

Disclosure

The authors report no conflicts of interest in this work.

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Development of a Japanese version of the Somatic Symptom Scale-8: Psychometric validity and internal consistency

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ABSTRACT

Objective: We aimed to psychometrically validate the Japanese version of the Somatic Symptom Scale-8 (SSS-8) in Japanese individuals.
Method: Data were collected from Japanese individuals aged 20–64 years, who were recruited online, in February 2015. The scale reliability and validity were analyzed.
Results: Data from 52,353 individuals were analyzed. Cronbach's alpha for the assessment of internal consistency reliability was 0.86 for the total score. The concurrent validity results showed strong correlations with three domains of the Profile of Mood States-Brief form ($\rho = 0.51$–0.61) and the EuroQol 5 Dimension ($\rho = -0.54$). The known-group validity results indicated a linear trend in the severity of depression stratified using the Patient Health Questionnaire-2 (Jonckheere-Terpstra test, $p < 0.001$). Regarding convergent and discriminant validities, all items correlated most strongly with their own domains (coefficients ≥ 0.5), except for one item (headaches). Scores on perceived stress, pain, and general health differed across five SSS-8 severity groups (Steel-Dwass test, $p < 0.001$), expect for one group pair in health.
Conclusion: The Japanese version of the SSS-8 was valid with good internal consistency. This questionnaire could help detect somatic symptom burdens of chronic and severe musculoskeletal pain for primary prevention.

1. Introduction

Somatic symptoms are generally considered manifestations of an underlying psychiatric illness, such as anxiety, depression, or common mental disorders [1]. Common symptoms include various types of pain (e.g., back pain, joint pain, headache), gastrointestinal symptoms (e.g., food intolerance, regurgitation of food, bloating), cardiopulmonary symptoms (e.g., sweating, palpitation, breathlessness), and excessive tiredness [2]. Somatic symptoms are associated with deterioration of quality of life and psychological distress and increased use of health care services [3,4].

The Somatic Symptom Scale-8 (SSS-8) is a self-administered questionnaire assessing somatic symptom burden [5]. The SSS-8 consists of eight items that assess the following symptoms: stomach or bowel problems; back pain; pain in your arms, legs, or joints; headaches; chest pain or shortness of breath; dizziness; feeling tired or having low energy; and trouble sleeping. These items comprise the four symptom domains of gastrointestinal, pain, cardiopulmonary, and fatigue. Respondents rate how much each symptom has bothered them during the previous 7 days and score each item from 0 to 4: not at all (0), a little bit (1), somewhat (2), quite a bit (3), and very much (4), with no reverse-coded items included. The total score, ranging from 0 to 32, is a simple sum of each item score: a higher score indicates more severe somatic symptom burden.

The SSS-8 was originally developed in English as an abbreviated version of the Patient Health Questionnaire-15 (PHQ-15) [4], a questionnaire used worldwide to assess the presence and severity of somatic symptoms [6–11]. The PHQ-15 was used as a reference measure in the Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition) (DSM-5) field trials to facilitate the diagnosis of somatic symptom disorder [12]. The German version of the SSS-8 has been linguistically and

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psychometrically validated and has shown good reliability and validity for the general German population [5] as well as psychometric equivalence to the PHQ-15 [13]. Whereas the PHQ-15 has been used internationally, the SSS-8 is newly developed but is expected to be a useful tool in busy medical settings because it requires little time to complete and score.

To make the SSS-8 available in Japan, we translated the English version into Japanese and conducted a linguistic validation of the scale [14]. To ensure conceptual equivalence between the original and its translation, the translation and linguistic validation were conducted as follows: (i) forward-translation by two independent Japanese translators; (ii) back translation by a native English speaker; and (iii) pilot testing for comprehension in five patients with a history of musculoskeletal pain and somatic symptoms. Through a step-by-step process, a linguistically validated Japanese version of the SSS-8 was successfully developed, yet its psychometric properties have not been assessed.

Thus, the objective of the present study was to psychometrically validate the Japanese version of the SSS-8 for assessment of somatic symptoms in Japanese individuals.

2. Methods

2.1. Study population

Members of the Japanese general population aged 20–64 years were included in the analysis. Participants were recruited by an Internet research company, United Inc. (Tokyo, Japan), with which >1.37 million individuals across Japan have voluntarily registered. Out of approximately 1.25 million individuals aged 20–64 years selected as eligible participants, 270,000 individuals were randomly selected and invited by e-mail to complete an online questionnaire.

Participation in the online surveys was voluntary and no personally identifiable information (e.g., name and address) was collected. All participants gave their consent and were compensated. After obtaining ethical approval from The University of Tokyo, the questionnaire administration was conducted in February 2015.

2.2. Measures

The administered questionnaire included questions on demographic and clinical characteristics, the SSS-8, the EuroQol 5 Dimension (EQ-5D) [15], the brief form of the Profile of Mood States (POMS) [16,17], the Patient Health Questionnaire-2 (PHQ-2) [18], and questions on perceived stress, subjective health, and perceived general health.

The EQ-5D is an instrument developed to measure general health status [15]. It contains five questions assessing mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [19]. All responses are converted into a single index score of general health status ranging from −0.11 to 1.00: a score of 1 indicates “perfect health” and a score of 0 indicates “death.” The Japanese version of the EQ-5D, which was approved by the EuroQol Group in 1997, has been widely used in research [20].

The POMS is a 65-item questionnaire that assesses the mood of individuals based on the following six mood construct domains: tension/anxiety, depression/dejection, anger/hostility, vigor, fatigue, and confusion. The present study used the POMS-Brief form, which consists of 30 items assessing the same six domains. Each item is rated on a five-point scale, and each domain score ranges from 0 to 20, with higher scores indicating more disturbances, except for the vigor domain. A Japanese version of the POMS-Brief form was shown to be reliable and valid [21].

The PHQ-2 is a questionnaire comprising two questions extracted from the universally used original Patient Health Questionnaire-9 [18]. The questions assess whether the respondent has experienced depression and anhedonia over the past 2 weeks. Although each item is rated on a scale of 0–3 in the original PHQ-2, the present study used the National Center of Neurology and Psychiatry version of the Japanese PHQ-2, which gives each item a binary response of yes or no [22]. Individuals who answer yes to at least one question are suspected of experiencing depression and a closer assessment of the individual is recommended.

Participants' perceived stress and subjective pain (including numbness) during the past 4 weeks were rated using a numerical rating scale (NRS) ranging from 0 to 10, with higher scores indicating greater stress/pain (numbness). Participants' current perceived health was also rated using an NRS on a scale of 0 to 10; a score of 0 indicates the worst health status and a score of 10 indicates the best health status.

2.3. Statistical analysis

Participants' demographic and clinical characteristics were analyzed descriptively. For descriptive statistics of the Japanese SSS-8, the total score and individual item scores were calculated to examine missing data and floor and ceiling effects (>60%).

To assess the psychometric properties of the Japanese version of the SSS-8, we evaluated its reliability and validity. Internal consistency was assessed to evaluate the reliability of the SSS-8. The extent to which items in the SSS-8 correlated with each other was evaluated using Cronbach's alpha coefficient. A Cronbach's alpha coefficient was computed for both total and symptom domain scores. A Cronbach's alpha of 0.7 or higher would indicate that the SSS-8 is internally consistent [23].

The validity was evaluated by assessing concurrent validity, known-group validity, and convergent and discriminant validity. Concurrent validity was assessed by examining associations between the SSS-8 and external reference questionnaires (EQ-5D and POMS) using Spearman's correlation coefficient. Scales that measure similar concepts should be strongly correlated; those measuring different concepts should be weakly correlated. The correlation coefficient was interpreted according to Cohen's criteria: 0.1 is considered a weak correlation; 0.3, moderate; and 0.5, strong [24].

For known-group validity, scores among different groups of participants based on the results of the PHQ-2 were examined. It was hypothesized that participant groups with more affirmative responses would have higher SSS-8 scores. To test whether there was such a linear trend across groups with different levels of depression, the Jonckheere-Terpstra test was performed [25,26]. The Jonckheere-Terpstra test is a non-parametric test, which tests if the SSS-8 scores increase as the number of affirmative response in the PHQ-2 increases, based on a hypothesis that the response distribution does not differ by the number of affirmative response.

Convergent and discriminant validity examined whether an individual item fits in its own domain (convergent validity) while the individual item does not fit in the other domains aside from its own domain (divergent validity). To assess convergent and divergent validity, the correlations between items and the symptom domains that those items assess (gastrointestinal, pain, cardiopulmonary, and fatigue domains) were calculated. It was hypothesized that items would strongly correlate with other items assumed to belong to the same symptom domain, and would weakly correlate with items assumed to belong to different symptom domains. The item-total correlations were evaluated using Spearman's correlation coefficient.

Additionally, we assessed the relationships between the Japanese SSS-8 severity groups and the participants' clinical status. Based on the SSS-8 total score, participants were categorized into five severity groups using the German version of the severity thresholds: a score of 0–3 was categorized as “no to minimal severity,” 4–7 as “low,” 8–11 as “medium,” 12–15 as “high,” and ≥16 as “very high” [5]. Among these five severity groups, all pairwise comparisons were conducted by the Steel-Dwass non-parametric test [27,28] to identify any pairs with statistically significant differences in perceived stress, subjective pain, and perceived general health.

All statistical tests were two-sided with a significance level of 0.05. Unanswered questionnaire items were treated as missing data. All analyses were performed using SAS software version 9.3 (SAS Institute, Inc., Cary, NC, USA).

3. Results

Data from 52,353 individuals who responded to the questionnaires were analyzed. Participants' demographic and clinical characteristics are summarized in Table 1. The median age was 43 years with a range of 20 to 64 years, and 50.0% of the participants were male. Median perceived stress, subjective pain, and perceived general health scores were 4 (3–6), 2 (1–4), and 6 (5–8), respectively.

Table 2 summarizes descriptive statistics of the Japanese SSS-8. To complete the questionnaire, respondents must answer all SSS-8 items; therefore, there was no missing data. No remarkable floor or ceiling effects were observed for the total scores. No ceiling effects were observed for the individual item scores; however, floor effects were observed for the following six items: stomach or bowel problems; pain in the arms, legs, or joints; headaches; chest pain or shortness of breath, dizziness; and trouble sleeping.

For reliability, internal consistency of the Japanese SSS-8 was evaluated using Cronbach's alpha coefficients. The Cronbach's alpha for the total score was 0.86, which demonstrates good consistency. The Cronbach's alpha coefficients within each symptom domain were 0.69 for the pain domain, 0.77 for the cardiopulmonary domain, and 0.77 for the fatigue domain.

To assess concurrent validity, Spearman's correlation coefficients for the associations between the SSS-8 and the two external criteria (EQ-5D, POMS) were calculated. A strong correlation was observed with the EQ-5D ($\rho = -0.54$), and also with the three POMS domains: 0.61 for the POMS-fatigue, 0.55 for the POMS-tension/anxiety, and 0.51 for the POMS-depression/dejection ($p < 0.001$ for all). For the remaining POMS domains, moderate to weak correlations were observed with the POMS-anger/hostility ($\rho = 0.46$), POMS-confusion ($\rho = 0.46$), and POMS-vigor domains ($\rho = -0.01$) ($p < 0.001$ for all).

To examine known-group validity, SSS-8 total scores were compared among groups categorized based on their responses to the PHQ-2 items: 71.6% of patients made no affirmative responses, 14.9% made one affirmative response, and 13.6% made two affirmative responses. As hypothesized, the median SSS-8 total scores and its interquartile ranges (25th–75th percentile) were higher in the groups with more affirmative responses to the PHQ-2 items: 2 (0–5) in the group with no affirmative responses, 5 (2–9) in the group with one affirmative response, and 8 (4–12) in the group with two affirmative responses. The statistical test results showed a linear increasing trend in the SSS-8 total score across these three PHQ-2 categories (which indicate suspected depression levels) (Jonckheere-Terpstra test, $p < 0.001$).

To test convergent and discriminant validity, item-total correlations were examined. Table 3 shows the Spearman's correlation coefficients between each SSS-8 item and other items belonging to the same or different symptom domains (gastrointestinal, pain, cardiopulmonary, or fatigue domains). Shaded cells in Table 3 indicate correlations between each item and the other items in the same symptom domain. Boldface text indicates each item's highest correlation, to show the domain with which it was most strongly associated. All the items except for headaches (item 4) showed the highest correlation with items within their own domain, and most of them demonstrated strong correlations ($\rho \geq 0.5$) ($p < 0.001$ for all correlations). Item 4 showed the highest correlation with the cardiopulmonary domain ($\rho = 0.48$) instead of with its own pain domain ($\rho = 0.38$).

The plausibility of the Japanese SSS-8 severity groups based on the SSS-8 total score was examined by comparing the median scores on perceived stress, subjective pain, and perceived general health in each severity group (Table 4). For both perceived stress and subjective pain, median NRS scores were higher for more severe category groups, and the score differences between any pair of severity groups were significant (Steel-Dwass test, $p < 0.001$). For perceived general health, median scores were lower for more severe category groups. As with the stress and pain scores, this indicates that participants in more severe groups experience greater symptom burden. The score differences were significant between all pairs of severity groups (Steel-Dwass test, $p < 0.001$) except for between the “high” and “very high” groups (Steel-Dwass test, $p = 0.13$).

Table 1
Participants' demographic and clinical characteristics ($n = 52353$).

Characteristics	
Age, years (median, range)	43 (20–64)
Sex, male (n, %)	26,191 (50.0)
Educational qualification (n, %)	
Junior high school	1293 (2.5)
High school	16,105 (30.8)
Vocational school	7105 (13.6)
Technical college	855 (1.6)
Junior college	5302 (10.1)
University	19,102 (36.5)
Graduate school	2191 (4.2)
Others	400 (0.8)
Employment status (n, %)	
Full-time employee	20,565 (39.3)
Part-time/contract employee	9945 (19.0)
Temporary staff	1783 (3.4)
Business executive	2903 (5.6)
Family business	765 (1.5)
Work at home	1267 (2.4)
Students	1861 (3.6)
Do housework	7843 (15.0)
Without job	4363 (8.3)
Others	1058 (2.0)
Perceived stress (NRS) (median, IQR)	4 (3–6)
Subjective pain (NRS) (median, IQR)	2 (1–4)
Perceived general health (NRS) (median, IQR)	6 (5–8)

Values are median (range), n (%), or median (IQR). IQR = interquartile range (25th–75th percentile); NRS = numerical rating scale (score range: 0 to 10).

4. Discussion

This study used data collected online from 52,353 individuals to assess the psychometric properties of the Japanese SSS-8, which had been linguistically validated previously. Overall, the results demonstrated that the Japanese SSS-8 had good internal consistency, and acceptable to good concurrent validity, known-group validity, and convergent and discriminant validities.

Although the descriptive statistics of the Japanese SSS-8 revealed no ceiling or floor effects for the Japanese SSS-8 total scores, a floor effect was observed for six individual items. This is probably because the present study sampled members of the Japanese general population, who did not necessarily have any somatic symptoms, and because item scores were between 0 and 4. In fact, over 50% of the participants obtained total scores of between 0 and 5. Therefore, these floor effects were not considered critical.

The internal consistency of the Japanese SSS-8 was evaluated here using Cronbach's alpha coefficient [29]. The coefficient exceeded a generally acceptable level of 0.7 for psychometric scales and reached over 0.8, which is regarded as a good level. These levels are similar to the Cronbach's alpha of 0.81 found for the German SSS-8 [5].

The validity of the Japanese SSS-8 was evaluated by examining concurrent validity, known-group validity, and convergent and discriminant validity. The concurrent validity analysis showed strong correlations exceeding 0.5 (or −0.5) between the Japanese SSS-8 and the measures of self-reported health status, fatigue, anxiety, and depression. Known-group validity was also found: there was a statistically significant trend for patients with more depression symptoms to report higher Japanese SSS-8 scores. Both the concurrent validity and known-group validity results found here indicate relationships between

Table 2
SSS-8 total scores and distributions of individual item scores.

	Mean	SD	Median	Range Min–Max	Floor effect (%)	Ceiling effect (%)
Total score	4.5	5.2	3	0–32	24.9	0.4
1. Stomach or bowel problems	1.6	0.9	1	1–5	64.4	1.5
2. Back pain	1.8	1.0	1	1–5	53.6	2.7
3. Pain in the arms, legs, or joints	1.5	0.9	1	1–5	67.0	1.9
4. Headaches	1.6	0.9	1	1–5	66.6	2.0
5. Chest pain or shortness of breath	1.3	0.7	1	1–5	83.9	1.1
6. Dizziness	1.3	0.7	1	1–5	81.0	1.3
7. Feeling tired or having low energy	1.9	1.1	1	1–5	50.1	3.9
8. Trouble sleeping	1.6	1.0	1	1–5	67.4	3.0

SSS-8 = Somatic Symptom Scale-8; SD = standard deviation; Min = minimum; Max = maximum.

somatic burden, anxiety, and depression, which supports previous research showing that somatic, anxiety, and depression symptoms are highly comorbid and partially overlap [30,31].

For the convergent and discriminant validities, the highest correlations were between each question item and the domain to which it belonged, with the exception of the headaches item. Headaches had the highest correlation with the cardiopulmonary domain (0.48), followed by the fatigue domain (0.45). Although headaches are a type of pain, they differ from back pain and pain in your arms, legs, or joints which are classified as musculoskeletal pain. Earlier research grouped headache into the category of general symptoms or head-and-gastrointestinal symptoms along with symptoms such as dizziness and fatigue as a result of factor analysis in somatic symptoms [32–34]. In fact, when looking into correlation between each items rather domains, headaches in the present study indicated the highest correlation with dizziness ($\rho = 0.45$) followed by feeling tired or having low energy ($\rho = 0.44$). Therefore, headaches showing such stronger correlations with the cardiopulmonary and fatigue domains may be accountable. Similarly in the German version of the SSS-8, confirmatory factor analysis results revealed coefficients of between 0.61 and 0.84; the lowest was for headaches and the highest for pain in the arms, legs, or joints in the pain domain [5]. This may have resulted from differences in sampling methods; however, the observed lowest coefficient for headaches in the present study is consistent with the German findings.

Furthermore, five severity thresholds from the German SSS-8 are applicable to the Japanese general population. For the German version of the SSS-8, the severity increased as levels of perceived stress, pain, and general health increased [5]. The differences between all pairs were statistically significant, except for the pair of high and very high in perceived general health. However, as the medians in high and very high were the same for perceived stress and general health, further research is warranted to determine whether the category cutoff points for high and very high are appropriate for the Japanese general population.

There are several limitations of the present study. First, generalization of these results is limited. As recruitment was conducted online, some demographic groups may have been under-represented (e.g., those without access to the Internet) and some over-represented (e.g., those with a greater motivation to participate). In addition, the recruitment targets were limited to registered individuals between the ages of 20 and 64 years (considered to be the working age population). However, the present study obtained a large sample from the general Japanese population and this sample reflected the age and sex composition ratio of the Japanese population. Therefore, such under- or over-represented groups may not be a critical problem in the present study. Second, misclassifications of response and recall bias are concerns. Response misclassification is inevitable when using subjective measures. Recall bias toward retrospective questions might also have distorted participants' responses. Therefore, these need to be interpreted with caution. Third, the present study did not evaluate the responsiveness of the Japanese SSS-8. The ability of the questionnaire to detect changes if the condition changes (e.g., responsiveness to treatment) needs to be evaluated prior to its use in longitudinal studies. Further assessment of responsiveness is thus necessary. Fourth, as the present study targeted the general population residing in Japan, use of the Japanese SSS-8 in a clinical setting may produce results that differ from the present results. The English version of the SSS-8, a short form of the PHQ-15 [4], was originally developed for the DSM-5 field trials [12], and its German version has been psychometrically validated for the German general population, suggesting that the SSS-8 could be applicable to both clinical and general populations [5]. However, the relevance of the Japanese SSS-8 for patients in Japan needs to be demonstrated.

Table 3
Correlations[a] among each item and other items belonging to the same or different symptom domains.

	Domain			
SSS-8 Item	Gastrointestinal Item #1	Pain Item #2–4	Cardiopulmonary Item #5–6	Fatigue Item #7–8
1. Stomach or bowel problems	**1.00**	0.46	0.41	0.45
2. Back pain	0.39	**0.51**	0.38	0.44
3. Pain in your arms, legs, or joints	0.32	**0.47**	0.38	0.38
4. Headaches	0.39	0.38	**0.48**	0.45
5. Chest pain or shortness of breath	0.38	0.43	**0.50**	0.43
6. Dizziness	0.36	0.43	**0.50**	0.44
7. Feeling tired or having low energy	0.43	0.52	0.47	**0.57**
8. Trouble sleeping	0.38	0.43	0.43	**0.57**

[a]Spearman's correlation coefficient.

SSS-8 = Somatic Symptom Scale-8. Item 1 comprises thegastrointestinal symptoms domain, items 2–4 comprise the pain domain, items 5–6 comprise the cardiopulmonary domain, and items 7–8 comprise the fatigue domain. All the correlations were $p < 0.001$.

Table 4
Stress, pain, and overall health NRS scores for each SSS-8 severity category.

SSS-8 severity category (SSS-8 score)	n (%)	Perceived stress (NRS) Median (IQR)	Subjective pain (NRS) Median (IQR)	Perceived general health (NRS) Median (IQR)
No to minimal (0–3)	29,294 (56.0)	3 (2–5)	1 (0–3)	7 (5–8)
Low (4–7)	12,243 (23.4)	5 (3–7)	3 (2–5)	6 (4–7)
Medium (8–11)	5731 (10.9)	6 (4–7)	4 (3–6)	5 (4–6)
High (12–15)	2725 (5.2)	7 (5–8)	5 (3–7)	4 (3–6)
Very high (≥16)	2360 (4.5)	7 (5–8)	6 (4–7)	4 (3–6)

Score differences between severity groups were tested ($p < 0.001$ for all pairs of severity groups in perceived stress and subjective pain and $p < 0.001$ for all pairs in perceived general health, except for a pair of high and very high groups, $p = 0.13$).
SSS-8 = Somatic Symptom Scale-8; NRS = numerical rating scale; IQR = interquartile range (25th–75th percentile).

In sum, the present study demonstrated that our linguistically validated version of the Japanese SSS-8 was valid with a good internal consistency. Our results also suggested that the somatic symptom burdens determined by the SSS-8 severity thresholds were in proportion to individuals' perceptions of stress and pain levels and inverse to their perception of health status. This brief questionnaire could be useful in a medical setting and could help to detect the somatic symptom burden of chronic and severe musculoskeletal pain for primary prevention.

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ORIGINAL ARTICLE

Fear-avoidance beliefs are independently associated with the prevalence of chronic pain in Japanese workers

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Abstract
Purpose Pain is a global public health problem with implications for both personal and social heath. Fear-avoidance beliefs (FABs) have been demonstrated to negatively impact and prolong pain in many Western countries, but little is known about the association between FABs and chronic pain (CP) in Asian countries, including Japan. We examined the relationship between FABs and CP in Japanese white-collar workers, a growing population with a high prevalence of CP.
Methods Questionnaires and company records were used to gather data from 433 Japanese white-collar workers. Data were related to experience of pain, participant sociodemographic/health/lifestyle characteristics, fear-avoidance beliefs [Tampa Scale for Kinesiophobia (TSK)], work-related psychosocial factors (Brief Job Stress Questionnaire), and depressive illness [Psychological Distress Scale (K6)]. Analysis of covariance and multilevel logistic regression modeling were used to analyze associations between the data while controlling for factors known to influence CP prevalence.
Results Prevalence rate of CP was 11.1% (48 of 433 persons). Adjusted odds ratios for participants with CP significantly increased in participants with high TSK scores, even after adjusting for factors known to influence CP prevalence.
Conclusion We found a significant association between high TSK scores and CP in Japanese white-collar workers when controlling for other known factors that influence CP such as work-related psychosocial characteristics and depressive conditions. This finding suggests that FABs are independently associated with prevalence of CP.

Keywords Chronic pain · Fear of movement · Fear-avoidance belief · TSK · White-collar workers · Occupational medicine

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Introduction

Pain is a health problem that dramatically effects the global population [1, 2]. In particular, chronic pain (CP) can impair the daily lives of its sufferers, as well as placing a substantial economic burden on a country's resources [3]. A number of large-scale surveys suggest that CP is prevalent in approximately 20–25% of the Japanese population [4, 5], with prevalence differing between different work-related occupations [6]. For example, prevalence of chronic musculoskeletal pain is typically higher within "white-collar" professional, office, and technical employees, despite lower levels of demanding physical tasks. In contrast, employees within the "blue-collar" agricultural, forestry, and fisheries industries report lower rates of such chronic pain [6].

To be able to prevent CP in white-collar workers (WCWs) would have substantial benefits in the lives of individuals who experience pain in their everyday lives. Furthermore, preventing CP effectively would also have economic and social benefits because of the association between CP and employment sick leave, absence, and poor productivity [7, 8]. The urgency to develop effective treatments and prevention strategies for CP is becoming increasingly more salient as there is a growing number of WCWs in the workforce [9], which thus increases the number of individuals experiencing CP.

Biological disorders are often considered as the primary causal factor for CP; however, it is also important to consider the effect of psychological and social factors, such as work-related stress and depression. In particular, dysfunctional beliefs relating to pain itself, and fear of pain, play a key role in the development of CP [10, 11]. Fear of pain can lead to avoidance of activities that patients associate with the occurrence or exacerbation of pain, even after physical recovery from the associated condition has occurred. The avoidance of physical activities based on fear of movement, known as kinesophobia, can also lead to a cycle of further fear and avoidance [12]. Moreover, excessive avoidance of activities believed to cause pain can reduce muscle strength and flexibility, which may delay recovery from a painful condition. This cycle of pain and avoidance behavior can be explained by a fear-avoidance model in which fear-avoidance beliefs (FABs) represent typical cognitive and emotional responses that can lead people with pain into a cycle of avoidance. Research has demonstrated that FABs contribute to long-term work-related disabilities; furthermore, low levels of FABs are a useful predictor of early recovery from an impairment [13, 14].

Although a number of studies in the United States and Europe have investigated the relationship between FABs and CP, very little research of a similar nature has taken place in Asian countries, including Japan. As the influence of FABs differs depending on culture and ethnicity [15], it is not possible to generalize the results from studies in Western populations to an Asian population. Our study aims to address this issue by investigating the prevalence of CP among Japanese WCWs, and furthermore, by analyzing the association between FABs and CP.

Methods

Data were collected from WCWs in the technology development division of a company listed on the First Section of the Tokyo Stock Exchange. Questionnaires were used to collect data relating to participants' pain, fear of pain, work-related psychosocial factors, and depression. We also collected data relating to participant demographics and lifestyle from the company's most recent employee health survey conducted within the year preceding the current study. The questionnaires were distributed to participants on February 10, 2015, and the survey was closed on February 29, 2015.

All procedures were approved by both the Keio University School of Medicine Ethics Committee (approval no. 20140296) and the Health and Safety Committee within the participating company. Participants were informed about the nature of the survey, and the use of demographic data from the annual health check, through the company's intranet.

Participants

In total, 517 full-time employees were asked to take part, with 433 returning completed questionnaires (83.8% response rate). Respondents were aged from 20 to 65 years old (mean = 41.5; standard deviation = 10.8). Male participants comprised the majority of the sample (375 participants, 86.8%). According to the company's data, all participants were recognized as WCWs who were engaged predominantly in deskwork.

Measures

Data were collected from the company's health check related to the participant's age, sex, body mass index (BMI, kg/m^2; participants categorized in quartiles), height, smoking habit (participants categorized as never, ex-smoker, or current smoker), daily alcohol intake [1 glass of sake (180 ml) was coded as 23 g ethanol; participants were categorized as consuming 0, 1–23, 24–45, or ≥46 g ethanol/day], highest education achieved (high school graduate or junior college graduate, bachelor's degree, master's degree, or doctorate), exercise routine, and daily working hours. Sleep patterns were evaluated for quantity of sleep in the past 4 weeks (participants categorized as having <5, 5, 6, 7, 8, 9, or >9 h/day) [16], with a reported sleep duration of less than 5 h coded as 'short sleep.' A measurement of participants' subjective evaluation of their exercise routine was also collected and used in the subsequent analyses.

Participants were asked to provide specific details of pain they had experienced during the previous 4 weeks relating to pain location(s), intensity, duration, and frequency. Location of pain was marked on an illustration by the participants (see Fig. 1), with multiple answers allowed. Pain intensity was scored on a numeric rating scale (NRS) comprising 11 points (0 = no pain to 10 = worst pain imaginable). Participants were coded as having CP when the following criteria were met: (1) NRS score of 5 or more, (2) pain persisted for at least 3 months, and (3) pain experienced at least two times a week [17].

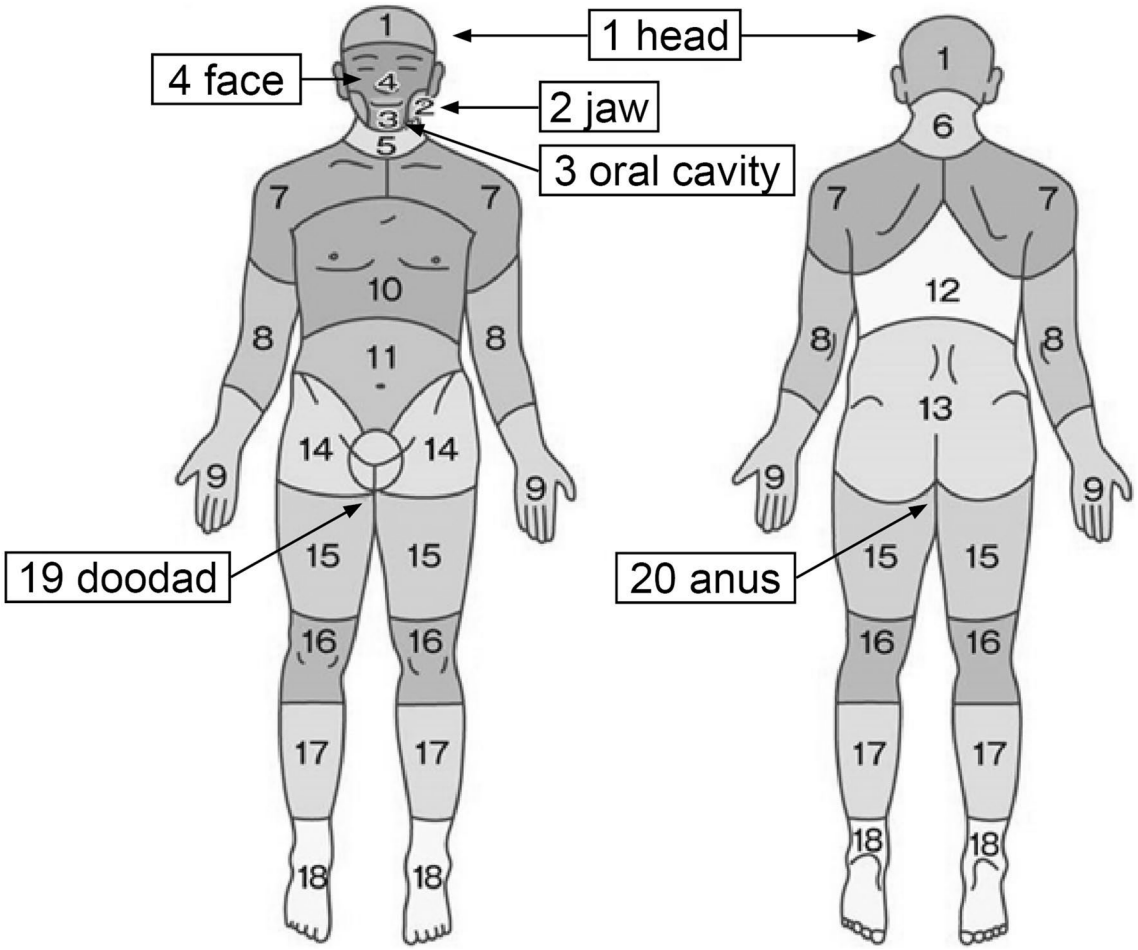

Fig. 1 Full-body manikin divided into 20 areas for marking of pain sites. Shoulder, back neck, low back, and head were defined as areas numbered *7*, *6*, *13*, and *1*, respectively

To evaluate kinesophobia within participants, we used the Japanese short version of the Tampa Scale of Kinesophobia (TSK-J11) developed and validated by Matsudaira et al. [18, 19]. Although a longer version of the TSK is available, we deemed the short version suitable for the study because of its good psychometric properties (Cronbach's $\alpha = 0.92$) and the advantage of brevity it offered [18, 20]. Reliability and validity of the TSK has been confirmed in several patient populations, including patients with chronic musculoskeletal pain [21], low back pain [22, 23], whiplash injury pain [24], shoulder pain [25], temporomandibular disorder [26], sciatica [27], and fibromyalgia [28]. The TSK-J11 comprises 11 items with each scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total score is obtained by summing the scores for the 11 items and ranges from 11 to 44. Higher scores indicate a greater degree of kinesophobia within participants.

Work-related psychosocial factors were measured in five different aspects (job demand, job control, social support from supervisors and co-workers, and job satisfaction) using subscales of the Brief Job Stress Questionnaire (BJSQ) [29]. All items, except job satisfaction, were respectively rated on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Job demand was calculated by summing the item scores for psychological job overload within the BJSQ (three items). Job control was calculated by summing the item scores for subjective adjustability of work within the BJSQ (three items). The questionnaire section on social support from supervisors and co-workers consisted of three items, respectively, with the total score calculated by summing the three items, and ranging from 3 to 12 (lower scores indicating greater levels of support). Job satisfaction was rated on a 4-point scale ranging from 1 (satisfied) to 4 (unsatisfied).

Depressive condition was measured using the Kessler Psychological Distress Scale (K6). The Japanese version was developed in 2008, and then reliability and validity were confirmed by Furukawa et al. (Cronbach's α was 0.85) [30]. The K6 was developed in 2002 as a short-form

version of the K10 [31] and consists of six items related to depression and anxiety, with each rated on a 5-point scale. In accordance with Kawakami, participants with a K6 score of 10 points or more were defined as having a depressive condition.

Statistical analysis

An analysis of Dunnett's test was conducted to test for differences in the age- and sex-adjusted means and proportions of participants' demographic and lifestyle characteristics. To investigate any association between kinesophobia and chronic pain, logistic regression was conducted to calculate multivariable-adjusted odds ratios (ORs) and 95% confidence intervals (95% CI). The data were fitted to three different regression models, with each adjusting for increasing numbers of variables. Model 1 adjusted for age, sex, BMI, smoking status, daily alcohol intake, highest education achieved, exercise habit, sleeping time, and working time. Model 2 also adjusted for job demands (categorized in tertiles), job control (categorized in tertiles), social support from supervisors and co-workers (categorized in quartiles), and job satisfaction (four categories) in addition to the control variables of model 1. Model 3 adjusted for depressive condition (K6 score $\geq$10) in addition to the control variables of model 2.

p values <0.05 for two-tailed tests were considered statistically significant. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

A total of 259 participants (60.0%) reported experiencing pain during the 4 weeks preceding the study, with 48 participants (11.1%) meeting the criteria for experiencing CP. The 211 participants who reported experiencing no pain in the previous 4 weeks were categorized into a non-CP group. The most frequently reported location of CP was in the shoulders (64.6%), followed by the back of the neck (54.2%), the low back (41.7%), and the head (31.3%).

Table 1 shows demographic characteristics of both the CP group and the non-CP group. Although no significant differences were observed between the groups for any of the items, there was a trend for higher BMI, poorer job control, poorer job satisfaction, and a higher rate of depressive people within the CP group when compared with the non-CP group.

Characteristics of participants who reported pain according to five categories of TSK-J11 scores are reported in Table 2. They were classified in quintiles as extremely low (Q1, 11–18), low (Q2, 19–20), intermediate (Q3, 21–23), high (Q4, 24–25), or extremely high (Q5, 26–44). Higher TSK-J11 scores were significantly associated with a greater prevalence of CP. In addition, a greater proportion of participants with high TSK-J11 scores reported poorer job control, poorer support from supervisors and co-workers, poorer job satisfaction, and a higher rate of depressive conditions (K6 score $\geq$10).

Table 3 illustrates the age- and sex-adjusted OR values for the CP versus non-CP groups according to TSK score. Significantly higher age- and sex-adjusted OR values of CP versus non-CP were observed among participants with extremely high TSK scores (Q5) compared to the participants with extremely low TSK scores. The OR values gradually increased for participants in the Q5 groups (3.13). In the first model, which adjusted for additional demographics and lifestyle variables, the Q5 group also exhibited significantly high OR values (3.13), with the difference remaining significant after adjusting for both the work-related psychosocial variables in model 2 (OR = 4.07) and the depressive symptom variables in model 3 (OR = 4.09). The stepwise increase in OR values with TSK score found in the columns of Q4 and Q5 also remained in all the models.

Table 1 Age- and sex-adjusted mean values and proportions of chronic pain risk factors

	Non-chronic pain	Chronic pain
n	211	48
Age, years (SE)	42.0 (0.7)	44.5 (1.5)
Men, *n*, %	185, 87.7%	40, 83.3%
Body mass index $\geq$25, *n*, %	42, 19.9%	12, 25.0%
Current smoker, *n*, %	15, 7.1%	4, 8.3%
Alcohol intake >46 g/day, *n*, %	32, 15.2%	9, 18.8%
Master's degree, *n*, %	156, 73.9%	37, 77.1%
Exercise >30 min twice a week, *n*, %	141, 66.8%	29, 60.4%
Sleep time 5 h or less, *n*, %	11, 5.2%	3, 6.3%
Working time $\geq$10 h, *n*, %	117, 55.5%	25, 52.1%
High job demands, *n*, %	66, 31.3%	17, 35.4%
Poor job control, *n*, %	71, 33.7%	23, 47.9%
Poor support from supervisor, *n*, %	65, 30.8%	16, 33.3%
Poor support from co-workers, *n*, %	59, 28.0%	11, 22.9%
Job dissatisfaction, *n*, %	51, 24.2%	15, 31.3%
K6 $\geq$10 points, *n*, %	11, 5.2%	4, 8.3%

No significant differences were observed between the groups for any of the items

SE standard error, *K6* Kessler Psychological Distress Scale

Table 2 Age- and sex-adjusted mean values and proportions of chronic pain risk factors according to the Tampa Scale for Kinesiophobia

	Tampa Scale for Kinesiophobia (TSK)				
	Q1 TSK = 11–18	Q2 TSK = 19–20	Q3 TSK = 21–23	Q4 TSK = 24–25	Q5 TSK = 26–44
n	52	37	61	38	63
Age, years (SE)	41.7 (1.5)	40.6 (1.7)	41.7(1.4)	44.2 (1.7)	43.9(1.3)
Men, *n*, %	42, 80.8%	31, 83.8%	51, 83.6%	36, 94.7%	57, 90.5%
Body mass index ≥ 25, *n*, %	11, 21.2%	5, 13.5%	14, 23.0%	6, 15.8%	16, 25.4%
Current smoker, *n*, %	2, 3.8%	4 10.8%	3, 4.9%	4, 10.5%	6, 9.5%
Alcohol intake more than 46 g/day, *n*, %	9, 17.3%	2, 5.4%	6, 9.8%	7, 18.4%	13, 20.6%
Master's degree, *n*, %	39, 75.0%	28, 75.7%	43, 70.5%	26, 68.4%	50, 79.4%
Exercise >30 min twice a week, *n*, %	38, 73.1%	21, 56.8%	44, 72.1%	30, 78.9%	33, 52.4%*
Sleep time 5 h or less, *n*, %	2, 3.8%	1, 2.7%	3, 4.9%	3, 7.9%	8, 12.7%
Working time ≥10 h, *n* (%)	33, 63.5%	20, 54.1%	35, 57.4%	23, 60.5%	27, 42.9%*
High job demands, *n*, %	24, 46.2%	9, 24.3%	17, 27.9%	12, 31.6%	17, 27.0%
Poor job control, *n*, %	8, 15.4%	16, 43.2%*	21, 34.4%	15, 39.5%*	32, 50.8%‡
Poor support from supervisor, *n*, %	9, 17.3%	14, 37.8%	13, 21.3%	15, 39.5%	28, 44.4%‡
Poor support from co-worker, *n*, %	9, 17.3%	6, 16.2%	18, 29.5%	10, 26.3%	24, 38.1%*
Job dissatisfaction, *n*, %	7, 13.5%	5, 13.5%	15, 24.6%	12, 31.6%	25, 39.7%†
K6 ≥10 points, *n*, %	3, 5.8%	4, 10.8%	10, 16.4%	7, 18.4%	15, 23.8%†
Chronic pain, *n*, %	6, 11.5%	4, 10.8%	6, 9.8%	10, 26.3%	20, 31.7%*

Test for significance from the category of Q1: * $p < 0.05$, † $p < 0.01$, ‡ $p < 0.001$

SE standard errors

Table 3 Odds ratios (ORs, 95% CI) of chronic pain versus non-chronic pain according to Tampa Scale for Kinesiophobia

	Tampa scale for kinesiophobia: TSK				
	Q1 TSK = 11–18	Q2 TSK = 19–20	Q3 TSK = 21–23	Q4 TSK = 24–25	Q5 TSK = 26–44
No. of subjects	52	37	61	38	63
No. of subjects with chronic pain	6	4	6	10	20
Age-adjusted mean values	1.00	0.80 (0.22–2.89)	0.70 (0.23–2.17)	2.43 (0.85–7.00)	3.09 (1.22–7.82)*
Model 1 OR (95% CI)	1.00	0.73 (0.18–2.89)	0.68 (0.21–2.20)	2.46 (0.82–7.42)	3.13 (1.17–8.37)*
Model 2 OR (95% CI)	1.00	0.76 (0.18–3.26)	0.65 (0.19–2.26)	2.73 (0.81–9.19)	4.07 (1.35–12.23)*
Model 3 OR (95% CI)	1.00	0.79 (0.18–3.40)	0.64 (0.18–2.22)	2.66 (0.79–8.98)	4.09 (1.35–12.42)*

Test for significance from the category of Q1: * $p < 0.05$, † $p < 0.01$, ‡ $p < 0.001$

SE standard error

Discussion

This is the first study demonstrating that kinesophobia adversely affects CP in Japanese employees. Because the biopsychosocial model makes a substantial contribution in explaining the complicated mechanisms that underpin CP [32], psychosocial factors should also be taken into account to identify the independent relationship between kinesophobia and CP. As such, we performed multiple logistic regression analyses controlling biological characteristics, work-related factors (psychosocial factors), and depression (psychological factor).

In model 1, we adjusted for demographic and lifestyle factors comprising age, sex, BMI, smoking status, daily alcohol intake, highest education achieved, exercise routine, sleeping time, and working time. Although exercise routine indicates low pain sensitivity [8, 33], high TSK scores were significantly associated with higher prevalence of CP, even after adjusting for factors including exercise. Although an exercise routine may alleviate kinesophobia and improve TSK score, the influence was statistically low in the present study.

In model 2, we investigated the effect of psychosocial factors on the relationship between kinesophobia and CP.

The demand-control model posits "high strain jobs" [jobs that combine high demand within a job and low job control (low decision latitude)] as having adverse effects on employees' health [34]. Furthermore, social support by supervisors and co-workers is argued to also be an influential psychosocial factor in the workplace [34], with the demand-control-support model suggesting that workplace support (as well as job control) can reduce a job stress induced by job demand. Another influential psychosocial factor is job satisfaction, referring to the overall well-being an employee feels toward their job [35]. Conversely, job dissatisfaction refers to the negative emotions elicited through a reciprocal deficit in effort-reward, illustrated in the imbalance model [36]. A number of studies have highlighted the importance of these factors, with poor work-related psychosocial factors associated with a higher prevalence of CP among European and North American employees [37–39], and job satisfaction significantly associated with CP in Japanese employees [40–42]. As such, we adjusted for work-related psychosocial factors in model 2 of the current study. The results indicated that, even after adjusting for work-related psychosocial factors, OR values for participants with extremely high TSK scores remained significant, suggesting that FABs influenced the prevalence of CP independently of the psychosocial factors.

In model 3, we also adjusted for depressive condition because previous research has demonstrated depression as an independent factor that adversely affects CP [42]. Job stress is also an indicator of depression [42]. As in model 2, the OR values in model 3 for participants with extremely high TSK scores remained significantly high after adjusting for depression, further supporting the view that kinesophobia is an independent risk factor of CP.

The prevalence of FABs in acute, or subacute, phases of painful conditions can prolong pain and lead to intractable conditions [43, 44]. As shown in this study, the independent association between FABs and the prevalence of CP suggests the similar negative impact of FABs on pain. Therefore, tackling FABs is an important therapeutic approach for reducing CP. The introduction of a psychosocial flag system for chronic musculoskeletal pain is one such approach and is strongly recommended in Europe and the United States. Under this system, FABs indicate a yellow flag, which requires the employee to receive treatment from clinical physicians working in collaboration with the workplace [45]. To effectively contend with CP, it is necessary for Japanese physicians to understand the complex nature of occupational health and CP and provide interventions that target pain in the earliest stages of onset.

There were a number of limitations in the current study. First, it is likely that selection bias influenced the results to some degree. The fact that the participating company positively accepted to take part in the study perhaps suggests that they have a strong interest in occupational health. However, even within a company that supports its employee's health, the present study demonstrated that more than one tenth of their employees suffered from severe chronic pain and FABs associated with CP. Unfortunately, it was impossible to infer the degree to which selection bias may have impacted the results because of the lack of other research focusing on the relationship between CP and occupational environments in Japan. More investigations will be expected to identify risk factors of CP in the work site. Second, data relating to the cause of pain were not collected. It is possible that classifications of pain may have influenced the present results; however, nociceptive and neuropathic pain classification of pain overlap in most patients who experience pain [46], which suggests that classifying pain in such a way is not necessary. Finally, because of the cross-sectional nature of the study, causality regarding the direction of influence between TSK and CP cannot be inferred. It is possible that long-lasting severe pain elevated TSK scores in participants who experienced pain. To clarify causality, future research should include panel data analysis.

In conclusion, we found a significant association between high TSK score and CP in Japanese white-collar workers when controlling for other known factors that influence CP, such as work-related psychosocial characteristics and depressive conditions. This result suggests that FABs are independently associated with the prevalence of CP.

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Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare.

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ORIGINAL RESEARCH

Sex-specific impact of early-life adversity on chronic pain: a large population-based study in Japan

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Background: Responses to early-life adversity may differ by sex. We investigated the sex-specific impact of early-life adversity on chronic pain, chronic multisite pain, and somatizing tendency with chronic pain.

Methods: We examined 4229 respondents aged 20–79 years who participated in the Pain Associated Cross-Sectional Epidemiological Survey in Japan. Outcomes were: 1) chronic pain prevalence, 2) multisite pain (≥3 sites) prevalence, and 3) multiple somatic symptoms (≥3 symptoms) among respondents with chronic pain related to the presence or absence of early-life adversity.

Multivariable-adjusted odds ratios (ORs) were calculated with 95% confidence intervals using a logistic regression model including age, smoking status, exercise routine, sleep time, body mass index, household expenditure, and the full distribution of scores on the Mental Health Inventory-5. We further adjusted for pain intensity when we analyzed the data for respondents with chronic pain.

Results: The prevalence of chronic pain was higher among respondents reporting the presence of early-life adversity compared with those reporting its absence, with multivariable ORs of 1.62 (1.22–2.15, $p<0.01$) in men and 1.47 (1.13–1.90, $p<0.01$) in women. Among women with chronic pain, early-life adversity was associated with multisite pain and multiple somatic symptoms; multivariable ORs were 1.78 (1.22–2.60, $p<0.01$) for multisite pain and 1.89 (1.27–2.83, $p<0.01$) for ≥3 somatic symptoms. No associations were observed between early-life adversity and chronic multisite pain or multiple somatic symptoms among men with chronic pain.

Conclusion: Early-life adversity may be linked to a higher prevalence of chronic pain among both sexes and to multisite pain and somatizing tendency among women with chronic pain.

Keywords: sex characteristics, early-life adversity, chronic pain, somatoform disorders, disaster

Introduction

Early-life adversity (ELA) is defined as traumatic experiences during childhood encompassing maltreatment, accidents, death of a close relative, and disaster, any of which could have an influence not only in childhood but also in later life in the form of difficulties such as posttraumatic stress disorder (PTSD) or irritable bowel syndrome.[1,2] Previous studies have also described the relationship between ELA events and chronic pain (e.g., low back pain or fibromyalgia), but most of these studies were small-scale or targeted to North American, European, Oceanian populations,[3–7] and once targeted to Japanese population.[8]

This study focuses on the effects of ELA as a broader concept in relation to chronic pain. We used a question about adverse life events in general, rather than specific adversities.

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Various sex or gender differences in tolerance for stressful life events have been documented. For example, a meta-analytic review revealed that women reported more symptoms of depression and anxiety than did men, but that the sex difference in psychological symptoms accounted for only about 4% of the variance in sex differences in reports of stress.[9] Sex or gender differences as they relate to chronic pain have been discussed for decades. The prevalence of chronic pain among women is higher than that among men,[10,11] and somatic symptoms have been reported by women than by men.[12,13]

We hypothesized that ELA would have long-term adverse impact, which manifested as chronic pain on more women than men, so we investigated the sex-specific association between ELA and the prevalence of chronic pain, chronic multisite pain, and somatizing tendency complicated by chronic pain in a large population-based study of Japanese men and women aged 20–79 years.

Methods

Ethical provisions

All procedures followed were in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2000. The institutional review boards of Keio University and of the Japan Labour Health and Welfare Organization approved this study. All participants had given their written informed consent before responding to the questionnaire. A credit point for Internet shopping was given as an incentive to the respondents.

Study population

The Pain Associated Cross-Sectional Epidemiological (PACE) study was a web-based survey designed to evaluate pain in a large Japanese population using a self-reported questionnaire. The PACE survey was conducted from 10 to 18 January 2009. The data set was the same as in previous PACE studies, profiles of which have been reported elsewhere;[14,15] however, the aim of this study was completely different from that of previous studies. Figure 1 shows the sampling procedure that culminated in the sample analyzed in the present study. A total of 20,044 respondents (9,746 men and 10,298 women) aged 20–79 years and matching the Japanese demographic composition in 2007 (Japanese Ministry of Internal Affairs and Communications, 2007) were recruited by e-mail from 1,477,585 candidates who registered with an Internet survey company (Rakuten Research, Inc., Tokyo, Japan). Computer-generated invitational e-mails were sent with a link to the first questionnaire until the targeted sample number was achieved. Incomplete questionnaires were rejected automatically, so the response rate was not calculated. The first questionnaire included items on age, sex, and pain, and was completed by 20,044 respondents. Subsequently, detailed questionnaires about lifestyle and psychosocial factors were sent to 5,000 of these respondents. Half (2,500) were chosen from those who had reported pain on the first questionnaire; the other half had reported being pain-free. The profile of these 5,000 respondents was consistent with the Japanese demographic composition for sex and age in 2007.[16] A total of 5,000 participants responded to the second questionnaire. Of these, we drew the data on 4,229 individuals (1,729 with chronic pain and 2,500 without pain) in the analyses. Moreover, the respondents with chronic pain were included in some additional analyses.

Definitions and measures

Chronic pain

The first questionnaire included items on pain such as the pain sites, pain intensity at each site, the site of dominant pain, and the duration of dominant pain. Pain intensities were scored on an 11-point Numerical Rating Scale (NRS; 0=no pain, 10=worst pain imaginable). In accord with the definition of chronic pain from the International Association for the Study of Pain, participants reported persistent pain over 3 months.[17]

Early-life adversity

We used a simple yes/no question to detect ELA, "Did you have any mentally shocking events (e.g., accidents experienced by you or close relatives, death of close relatives or friends, disaster, injury from violence) when you were 14 years old or younger?".

Multisite pain

The questionnaire included a picture of a human form with its body parts numbered from 1 to 21, and respondents entered the number(s) that corresponded to their pain site(s). A count of pain sites is a simple and useful measure for the severity of chronic pain, and chronic multisite pain is a strong predictor of future disability.[18] We defined more than three pain sites as multisite pain in the current study.

Somatizing tendency

Somatic symptom disorder involves having physical symptoms such as fatigue or dizziness caused by major emotional distress and problems functioning.[19] The disorder decreases its sufferers' quality of life. The Brief Symptom Inventory (BSI) is a self-reported measure of somatic symptoms, in which respondents answer on a 5-point Likert-type scale,

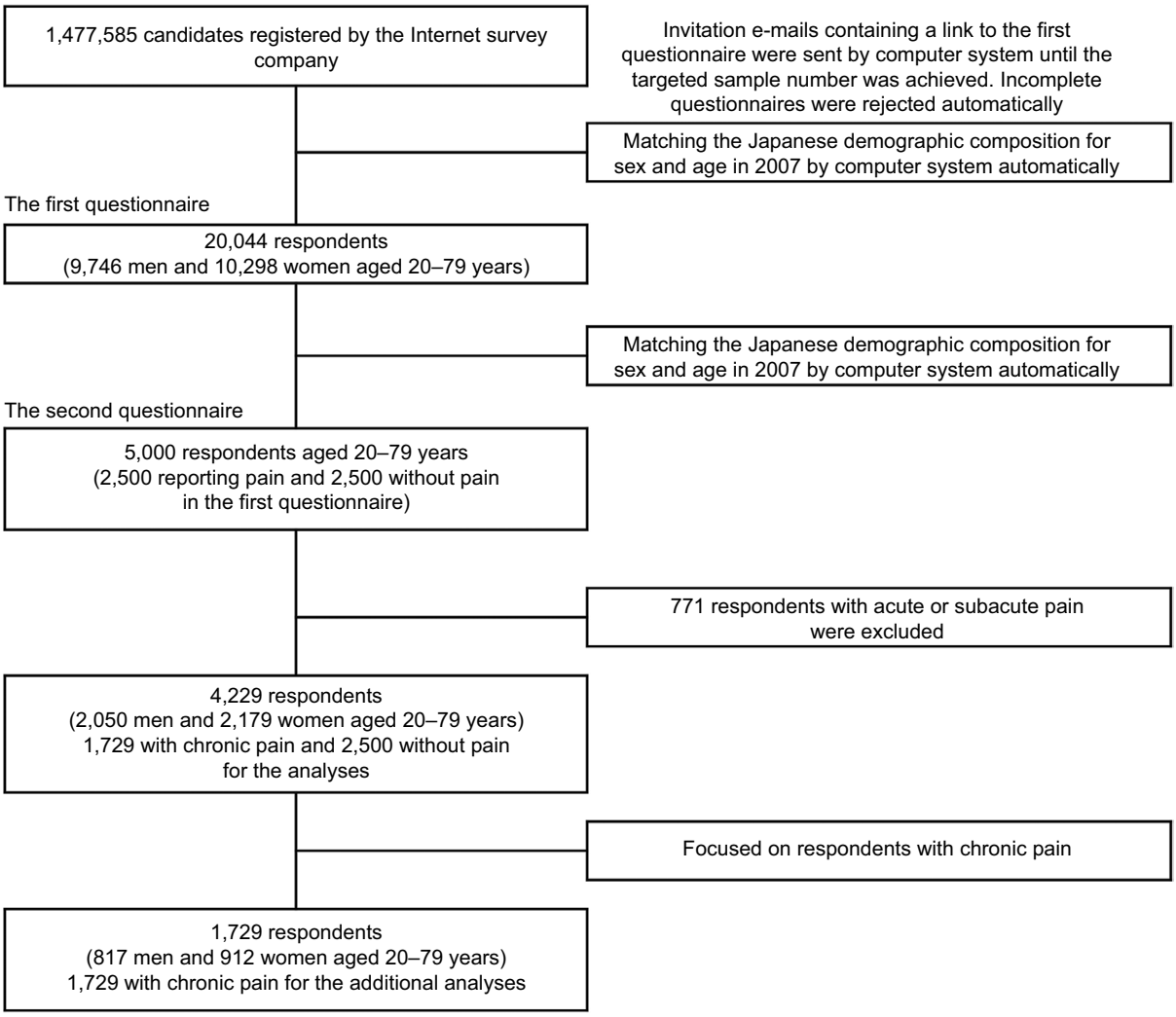

Figure 1 Flowchart of the sampling procedure ending in the sample being analyzed in the current study.

ranging from 0 (not at all) to 4 (extremely), regarding each of seven symptoms during the past 7 days: faintness or dizziness, pain in the heart or chest, nausea or upset stomach, trouble catching one's breath, numbness or tingling in parts of one's body, feeling weak in parts of one's body, and hot or cold spells.[20] Endorsing a response of 2, 3, or 4 was considered presence of the symptom. The number of symptoms with this level of response was counted; the totals ranged from zero to seven symptoms. We defined respondents with ≥3 symptoms, the highest tertile of the symptom count in our data, as existence of the somatizing tendency.

Mental status

We used the Mental Health Inventory (MHI-5), which is identical to the 36-item Short Form Health Survey (SF-36) "Mental Health" domain, to measure mental status.[21,22] The MHI-5 includes the following five questions: "How much of the time during the last month have you: 1) been a very nervous person?, 2) felt downhearted and blue?, 3) felt calm and peaceful?, 4) felt so down in the dumps that nothing could cheer you up?, and 5) been a happy person?". The respondents choose a number from 1 (all of the time) to 6 (none of the time).[21] The total score, which ranges from 5 to 30 points, is converted to a 100-point scale.[21] A previous Japanese study validated the cut point of <52 on the MHI-5 as screening for severe depressive symptoms.[21]

Statistical analysis

A Student's *t*-test was conducted to test for differences in age-adjusted mean values and proportions of risk factors for chronic pain. A chi-square test was performed to test for sex differences in the proportion of ELA.

Three outcomes were measured in the current study, 1) chronic pain prevalence among all respondents, 2) chronic multisite pain (≥3 sites) prevalence, and 3) multiple somatic symptoms (≥3 symptoms) among respondents with chronic pain, as these variables related to the presence or absence of ELA.

Multivariable-adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated using a logistic regression model to compare respondents with and without ELA.

p-Values <0.05 for two-tailed tests were considered statistically significant. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA).

Confounding variables

We adjusted all analyses for the following confounding variables: age, smoking status (never, ex-smoker, or current smoker), have an exercise routine (exercise longer than 30 minutes more than twice a week; yes or no), sleep time (hours/day), body mass index (kg/m^2, categorized in quintiles), household expenditure (JPY/month), and the full distribution of scores on the MHI-5.

We further adjusted for pain intensity (the NRS that ranged from 0 to 10, i.e., 0=no pain, 10=worst pain imaginable) when we analyzed the data for respondents with chronic pain.

Results

Table 1 shows age-adjusted mean values of chronic pain risk factors according to the existence of ELA. Men with ELA were older (52.0 vs. 47.9 years), were more likely to have an exercise routine (45.9% vs. 33.7%), had a higher prevalence of body mass index ≥25 (31.8% vs. 24.8%), had higher household expenditures (380,000 vs. 293,000 JPY/month), had a higher proportion of severe depressive symptoms (27.3% vs. 19.5%), and had a higher prevalence of chronic pain (53.7% vs. 38.0%) compared with those who did not report ELA. Women with ELA had a higher prevalence of body mass index ≥25 (20.7% vs. 11.9%), severe depressive symptoms (38.5% vs. 20.2%), chronic pain (55.0% vs. 39.7%), and severe intensity of pain (6.5% vs. 6.1%) compared with those without it.

The prevalence of ELA was higher in women than in men (14.2% of women, 11.8% of men; $p<0.01$).

Multivariable-adjusted ORs of chronic pain prevalence of respondents with ELA are shown in Table 2. Multivariable-adjusted OR of chronic pain prevalence of men with ELA was 1.62 (1.22–2.15, $p<0.01$), and that of women with ELA was 1.47 (1.13–1.90, $p<0.01$).

Table 3 indicates multivariable-adjusted ORs of multisite pain (≥3 sites) among chronic pain sufferers with ELA. ELA was associated with higher risk for multisite pain among female chronic pain patients: multivariable-adjusted OR was 1.78 (1.22–2.60, $p<0.05$). However, there was no such association for men: multivariable-adjusted OR was 1.38 (0.88–2.16, $p=0.26$).

Table 1 Age-adjusted mean values and proportions of chronic pain risk factors

Chronic pain risk factors	Early-life adversity (–)	Early-life adversity (+)
Men		
n=2,050	1,808	242
Age, years, mean (SE)	47.9 (0.4)	52.0 (1.0)*
Current smoker, %	27.8	28.1
Have an exercise habit, %	33.7	45.9**
Sleep time <5 hours, %	3.4	5.0
Body mass index ≥25, %	24.8	31.8***
Household expenditure (*10,000 JPY/month)	29.3	38.0***
Severe depressive symptoms, %	19.5	27.3*
Chronic pain, % (no. of respondents with chronic pain=817)	38.0	53.7*
Intensity of pain among respondents with chronic pain (0–10 scale)	5.7	5.7
Women		
n=2,179	1,870	309
Age, years, mean (SE)	48.8 (0.4)	49.0 (0.9)
Current smoker, %	14.9	18.4
Have an exercise habit, %	29.0	33.3
Sleep time <5 hours, %	2.5	3.6
Body mass index ≥25, %	11.9	20.7*
Household expenditure (*10,000 JPY/month)	27.1	25.5
Severe depressive symptoms, %	20.2	38.5*
Chronic pain, % (no. of respondents with chronic pain=912)	39.7	55.0*
Intensity of pain among respondents with chronic pain (0–10 scale)	6.1	6.5***

Notes: Test for significance difference from the category of no early-life adversity: *$p<0.001$, **$p<0.01$, ***$p<0.05$.
Abbreviation: SE, standard error.

Table 2 ORs and 95% CIs of chronic pain prevalence of respondents with early-life adversity

	Early-life adversity (–)	Early-life adversity (+)
Men		
Number of respondents at risk	2,172	294
Number of respondents with chronic pain	687	130
Age-adjusted OR (95% CI)	1.00	1.86 (1.42–2.43)*
Multivariable-adjusted OR (95% CI)	1.00	1.62 (1.22–2.15)**
Women		
Number of respondents at risk	2,178	356
Number of respondents with chronic pain	742	170
Age-adjusted OR (95% CI)	1.00	1.86 (1.46–2.37)*
Multivariable-adjusted OR (95% CI)	1.00	1.47 (1.13–1.90)**

Notes: ORs are adjusted for age, smoking status, exercise routine, sleep time, body mass index, personal consumption expenditure, and the full distribution of scores on the Mental Health Inventory-5. Test for significant difference from the category of no early-life adversity: *$p<0.001$, **$p<0.01$.
Abbreviations: CI, confidence interval; OR, odds ratio.

Table 3 ORs and 95% CIs for multisite pain in chronic pain sufferers with early-life adversity

	Early-life adversity (–)	Early-life adversity (+)
Men		
Number of chronic pain sufferers	687	130
Number of chronic pain sufferers with multisite pain (≥3)	283	59
Age-adjusted OR (95% CI)	1.00	1.57 (1.06–2.34)***
Multivariable-adjusted OR (95% CI)	1.00	1.38 (0.88–2.16)
Women		
Number of chronic pain sufferers	742	170
Number of chronic pain sufferers with multisite pain (≥3)	379	117
Age-adjusted OR (95% CI)	1.00	2.27 (1.62–3.18)*
Multivariable-adjusted OR (95% CI)	1.00	1.78 (1.22–2.60)**

Notes: Adjusted for age, smoking status, exercise routine, sleep time, body mass index, household expenditure, the full distribution of scores on the Mental Health Inventory-5, and intensity of pain.Test for significant difference from the category of no early-life adversity: *p<0.001, **p<0.01, ***p<0.05.
Abbreviations: CI, confidence interval; OR, odds ratio.

Table 4 ORs and 95%CIs for multiple somatic symptoms among chronic pain sufferers with early-life adversity versus no early-life adversity

	Early-life adversity (–)	Early-life adversity (+)
Men		
Number of chronic pain sufferers	687	130
Number of multiple somatic symptoms (≥3)	283	59
Age-adjusted OR (95% CI)	1.00	1.57 (1.06–2.34)***
Multivariable-adjusted OR (95% CI)	1.00	1.27 (0.83–1.94)
Women		
Number of chronic pain sufferers	742	170
Number of multiple somatic symptoms (≥3)	379	117
Age-adjusted OR (95% CI)	1.00	2.10 (1.46–3.00)*
Multivariable-adjusted OR (95% CI)	1.00	1.89 (1.27–2.83)**

Notes: Adjusted for age, smoking status, exercise routine, sleep time, body mass index, household expenditure, the full distribution of scores on the Mental Health Inventory-5, and intensity of pain. Test for significant difference from the category of no early-life adversity: *p<0.001, **p<0.01, ***p<0.05.
Abbreviations: CI, confidence interval; OR, odds ratio.

In Table 4, ORs of multiple somatic symptoms (≥3 symptoms) for ELA among chronic pain sufferers are shown. The multivariable-adjusted OR of multiple somatic symptoms was 1.89 (1.27–2.83, p<0.01) for women with ELA. For men, ELA was not associated with somatic symptoms.

Discussion

The aim of this study was to examine the sex-specific impact of ELA on chronic pain, chronic multisite pain, and somatizing tendency with chronic pain. We hypothesized that ELA would have long-term adverse impact, which manifested as chronic pain on more women than men. The association of ELA with chronic multisite pain and with somatizing tendency among chronic pain sufferers supported our hypothesis. Although the significant associations were observed in women only, there was no sex difference in the association of ELA with the prevalence of chronic pain. Data from the Adverse Childhood Experience (ACE) study, which included 17,337 adults in the USA, also showed that ELA was associated with the prevalence of headache and with more frequent headaches in women than in men.[23]

ELA may reduce the volume of the hippocampus and prefrontal cortex; this reduction has been linked to major depression and to trait anxiety in adulthood, and predicts sensitivity to future stress events.[24,25] A magnetic resonance imaging study showed that 38 patients with chronic back pain and 30 patients with complex regional pain syndrome had a significantly smaller volume of bilateral hippocampal tissue than those of 50 healthy volunteers, whereas 20 patients with osteoarthritis did not.[26] Additionally, mice with neuropathic pain, in comparison with sham mice, showed more cellular and molecular changes linked to reduction of hippocampal function,[26] so reduction in the volume of the hippocampus due to ELA may actually cause chronic pain.

Moreover, sex differences in central sensitization could support our results. Central sensitization is the phenomenon in which nociceptive pain input from the peripheral nervous system triggers a prolonged but reversible synaptic change of pain pathways in the central nervous system.[27] Central sensitization contributes to the development of persistent pain hypersensitivity, spreads pain sensitivity across peripheral nerve territories without inflammation,[27] and amplifies pain from rheumatoid arthritis, osteoarthritis, fibromyalgia, and headache, as well as neuropathic pain, complex regional pain syndrome, and postsurgical pain.[27] Sex differences in enhanced pain sensitivity among patients with symptomatic knee osteoarthritis have been reported.[28]

In a psychological approach to chronic pain patients, especially women complaining of multisite pain or exhibiting somatizing tendencies, an intervention that addresses ELA should be considered.

Limitations

There were some limitations in this study. First, recall bias could exist because the current study was a cross-sectional design. The fact that people with persistent chronic pain are more likely to recall their ELA has been documented elsewhere.[29] Second, we used a simple and unvalidated question on ELA. A previous study of ELA among adolescents used a semi-structured interview that had good inter-rater reliability, and that study reported an association between ELA and depression.[30] Like that study, the current investigation concluded that respondents

with ELA showed a higher prevalence of depressive syndrome than did those without it. We believe that our single item on ELA was an appropriate proxy for the validated questionnaire. Third, the respondents may not be truly representative of the general population in Japan. The sampling issues with web-based surveys have been described previously.[31] Elderly people often have difficulty participating in such surveys. Moreover, the decision to respond to the survey may constitute selection bias, that is, the respondents who were suffering from chronic pain may have been particularly interested in pain research.

Conclusion

ELA was associated with a higher prevalence of chronic pain in both sexes, and with chronic multisite pain and somatizing tendency among women with chronic pain in the Japanese general population.

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Disclosure

The authors report no conflict of interest in this work.

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ORIGINAL RESEARCH

Estimated risk for chronic pain determined using the generic STarT Back 5-item screening tool

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Objective: The generic STarT Back 5-item screening tool (STarT-G) is used to manage chronic pain in the lower back and elsewhere. This study evaluated the validity of the Japanese version of this generic screening tool.

Materials and methods: Japanese participants between the ages of 20 and 64 years completed online surveys regarding pain. Survey reliability was assessed with internal consistency, as calculated using Cronbach's alpha coefficients. Spearman's correlation coefficients were used to evaluate concurrent validity between the STarT-G score and standard reference questionnaires. Associations between STarT-G scores and the presence of a disability due to chronic pain (DCP) were analyzed using receiver operator characteristic (ROC) curves.

Results: Analyses ultimately included data obtained from 52,842 Japanese participants (54.4% male) with a mean (standard deviation) age of 47.7 (9.4) years. Approximately 1.5% of participants had DCP, and the mean STarT-G score was 1.2 (1.4). The Cronbach's alpha coefficient was 0.71, indicating an acceptable reliability. The STarT-G score moderately correlated with the pain numerical rating scale (NRS) score (Spearman's correlation coefficient: $r = 0.34$). When the STarT-G threshold was set at 4, the sensitivity and specificity of the DCP predictive model were 65.8% and 82.4%, respectively, and the area under the ROC was 0.808.

Conclusion: The STarT-G was internally consistent and was able to distinguish between subjects with and without a DCP. Therefore, the STarT-G can reliably be used in the Japanese population to identify patients with DCP.

Keywords: chronic pain, disability, primary care, psychological factors, screening tool, somatic symptoms

Introduction

Disability due to chronic pain (DCP) results in absence from work and is a major public health concern in Japan and many Western countries.[1–4] Various screening tools have been developed to identify chronic pain subgroups and comorbid factors.[5–7] A widely used powerful tool is the STarT Back Tool (STarT), a 9-item screening tool that was developed as a prognostic indicator of lower back pain (LBP). Items 1–4 evaluate physical factors and items 5–9 assess psychosocial factors (Figure 1).[5,8] The STarT score is often used by primary care physicians in England to make clinical decisions.[5] Specifically, the STarT results indicate the subgroup that an LBP patient falls into, which helps determine which treatment strategies may be most effective. The STarT has been shown to be particularly effective for individual patient management in the physiotherapy setting. Patients who underwent STarT testing and subsequent targeted therapy had higher clinical and cost efficacy than patients who did not undergo STarT

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Patient name: _____ Date: _____

Thinking about the **last 2 weeks** tick your response to the following questions:

		Disagree 0	Agree 1
1	My back pain has **spread down my leg(s)** at some time in the last 2 weeks	☐	☐
2	I have had pain in the **shoulder** or **neck** at some time in the last 2 weeks	☐	☐
3	I have only **walked short distances** because of my back pain	☐	☐
4	In the last 2 weeks, I have **dressed more slowly** than usual because of back pain	☐	☐
5	It's not really safe for a person with a condition like mine to be physically active	☐	☐
6	**Worrying thoughts** have been going through my mind a lot of the time	☐	☐
7	I feel that **my back pain is terrible** and **it's never going to get any better**	☐	☐
8	In general I have **not enjoyed** all the things I used to enjoy	☐	☐

9. Overall, how **bothersome** has your back pain been in the **last 2 weeks**?

Not at all	Slightly	Moderately	Very much	Extremely
☐	☐	☐	☐	☐
0	0	0	1	1

Total score (all 9): _____ **Sub Score (Q5-9):**_____

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Figure 1 The Keele STarT Back screening tool (9-item).
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testing and were treated with usual care strategies.[5] We previously translated the STarT into Japanese,[9] and this version was linguistically validated in a general cross-cultural adaptation process.[10–12] We also evaluated the reliability and validity of "the STarT into Japanese" in a large number of Japanese patients with LBP.[13]

The lower back was the most common site of chronic pain and accounted for 65% of all cases of reported chronic pain in a Japanese epidemiological study.[1] However, chronic pain often originates in places other than the lower back, and a generic screening tool is needed to help effectively manage chronic pain from all sites. One such tool is the generic version of the STarT Back 5-item screening tool (STarT-G), a modified version of the 9-item STarT.[8] The STarT 9-item screening tool provides an easy way to stratify patients into three subgroups according to the probability of a poor prognosis or pain chronicity. These categories are defined as "low risk," "medium risk," and "high risk" (Figure 2).[8] On the other hand, the use of STarT-G (5-item) screening tool has not yet been established. The STarT-G has also not been validated for evaluating chronic pain in a large group of Japanese subjects. Therefore, the current study was performed to examine the validity of STarT-G in such a population using cross-sectional data obtained from STarT-G surveys administered online.

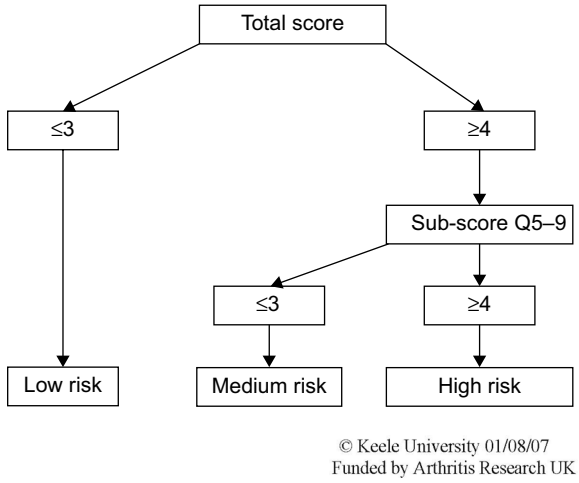

Figure 2 The STarT Back tool scoring system.
Notes: Scores were used to stratify patients into "low risk," "medium risk," and "high risk" groups. Copyright ©2007. Reprinted from Keele University. STarT Back Screening Tool Website. Available from: https://www.keele.ac.uk/sbst/startbacktool/usingandscoring/.[8]

Materials and methods

This study was reviewed and approved by the medical/ethics review board of the Japan Labour Health and Welfare Organization at Kanto Rosai Hospital (Kanagawa, Japan, approval number: 2012-22). All study procedures adhered to the tenets of the Declaration of Helsinki. Participation was voluntary, and no personal information was collected. Written informed consent was not obtained, but submitting the completed questionnaire was considered evidence of consent. Before completing the questionnaire, potential participants read an explanation of the survey's purpose and were informed that they should proceed to the questionnaire only if they agreed to participate in the study. As an incentive, participants received online shopping reward points from the Internet research company that helped conduct this study (UNITED, Inc., Tokyo, Japan).

Study population

Subject information was collected via surveys administered online in January and February 2014. Participants were recruited from an online panel conducted by an Internet research company (UNITED, Inc.). The all-Japanese study population consisted of ~1.25 million registered research volunteers between the ages of 20 and 64 years. From this volunteer pool, 965,919 individuals were randomly selected and invited by e-mail to complete an online questionnaire on health problems associated with pain. We ultimately obtained 52,842 online responses by January 31, 2014.

Study measures

The 5-item STarT-G tool is a modified version of the 9-item psychosocial subscale that specifically identifies distress in other conditions.[5] Questions address fear (one item from the Tampa Scale of Kinesiophobia), anxiety (one item from the Hospital Anxiety and Depression Scale), pessimistic patient expectations (one item from the Pain Catastrophizing Scale), low mood, (one item from the Hospital Anxiety and Depression Scale), and how bothersome pain is.[7] The first four items had possible responses of "agree" or "disagree," and the bothersome item had possible responses from 0 to 5 (Likert scale). We used the 5-item STarT back screening tool that is available from the Keele University website (March 2013, Figure 3).[8]

The study questionnaire investigated pain experienced over the past month in 20 different anatomical sites. All anatomical sites were illustrated on diagrams to ensure that participants correctly identified each area. Examined sites included the head, chin, teeth/mouth, face, throat, neck, shoulder, elbow, wrist/hand, chest, abdomen, back, low back, hip, thigh, knee, lower leg, ankle/foot, genitals, and anus. The degree of chronic pain experienced over the last 4 weeks was assessed using the numerical rating scale (NRS), with scores ranging from 0 (no pain at all) to 10 (the worst pain imaginable).

Somatizing tendency was assessed using a subset of items from a linguistically validated Japanese version of the Brief Symptom Inventory (BSI).[14,15] Seven somatic symptoms were assessed for severity, including faintness or dizziness, pain in the heart or chest, nausea or upset stomach, difficulty breathing, numbness or tingling in part of the body, weakness in part of the body, and hot or cold spells. All symptoms were assessed on a five-point scale that evaluated how much the participant was bothered by the symptom. Participants chose from the following response options: not at all (0), mildly (1), moderately (2), quite a bit (3), and extremely (4). For this test, participants were grouped by the number of somatic symptoms or pain sites. A participant was considered to have a symptom if he/she responded with a 2–4, which is indicative of somatization.[16,17]

The presence/absence of a DCP was also investigated. A DCP was considered present when the pain symptoms had continued for at least 6 months and the subject had withdrawn from social activities because of pain.

Statistical analyses

Data are presented as mean (standard deviation), where applicable. Participant demographic and clinical characteristics were summarized using descriptive statistics. To examine floor and ceiling effects, the percentages of respondents with total scores of 0 and 5 were calculated. Floor and ceiling effects were considered present when >15% of respondents had the lowest or highest possible score, respectively.[18] To examine STarT-G reliability, we evaluated

Patient name: _____ Date: _____

Thinking about the **last 2 weeks** tick your response to the following questions:

		Disagree 0	Agree 1
1	It's really not safe for a person with a condition like mine to be physically active	☐	☐
2	**Worrying thoughts** have been going through my mind a lot of the time in the last 2 weeks	☐	☐
3	I feel that **my problem is terrible** and that **it's never going to get any better**	☐	☐
4	In general in the last 2 weeks, I have **not enjoyed** all the things I used to enjoy	☐	☐

5. Overall, how **bothersome** has your condition been in the last 2 weeks?

Not at all	Slightly	Moderately	Very much	Extremely
☐	☐	☐	☐	☐
0	0	0	1	1

Score_____

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Figure 3 The generic condition screening tool (5-items).
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internal consistency by calculating Cronbach's alpha coefficients. An alpha index >0.70 indicates a satisfactory internal consistency.[19] Spearman's correlation coefficients were used to evaluate concurrent validity by examining correlations between STarT-G and NRS pain scores. Correlation coefficients were interpreted using Cohen's[20] criteria for correlation strength in psychometric validation (0.10 = weak, 0.30 = moderate, and 0.50 = strong).

The ability of STarT-G scores to differentiate between participants with known differences (known-group validity) was examined using the Jonckheere–Terpstra test. To do this, participants were categorized into the following groups according to the number of somatic symptoms present: no symptoms, one symptom, and two or more symptoms.

Associations between STarT-G scores and the presence of a DCP were examined using receiver operator characteristic (ROC) curves and the corresponding area under the curve (AUC). Accuracy was determined using the AUC. The following traditional academic point system for AUC values can be used as a rough guide for classifying diagnostic test accuracy: 0.90–1.00 = excellent, 0.80–0.90 = good, 0.70–0.80 = fair, 0.60–0.70 = poor, and 0.50–0.60 = fail.[21] Statistical analyses were performed using SPSS statistical software (version 20.0; SPSS, Inc., Chicago, IL, USA). All reported P values are two-sided, and statistical significance was defined as $P < 0.05$.

Results

A total of 52,842 participants were ultimately included in analyses. Mean subject age was 47.7 (9.4) years, and 54.4% of participants were male. Approximately 1.5% of participants claimed to have experienced a DCP. Table 1 summarizes participant demographic characteristics and overall pain survey results.

Mean STarT-G score was 1.2 (1.4). A remarkable ceiling effect was not observed, with only 2.3% of participants reporting the highest score of 5. However, a substantial floor effect was observed, with 41.0% of participants reporting the lowest score of 0. The Cronbach's alpha coefficient was

Table 1 Participant demographic and pain characteristics

Characteristics	
Sex, n (%)	
Male	28,769 (54.4)
Female	24,073 (45.6)
Age, years	47.7 (9.4)
BMI, kg/m^2	22.8 (3.8)
STarT-G score	1.2 (1.4)
NRS for pain	3.1 (2.4)
Pain sites, n (%)	
0	12,045 (22.8)
1	14,076 (26.6)
2	10,014 (19.0)
3	6,370 (12.1)
4–5	6,188 (11.7)
6–9	3,484 (6.6)
10+	665 (1.3)
Disability due to chronic pain, n (%)	
Present	818 (1.5)
Absent	52,024 (98.5)

Note: Data presented as mean (standard deviation) where applicable.
Abbreviations: BMI, body mass index; STarT-G, generic version of the STarT Back 5-item screening tool; NRS, numerical rating scale.

0.71, indicating good test reliability. Concurrent validity was examined by investigating the correlation between STarT-G score and pain NRS. The two pain measures were only moderately correlated ($r = 0.34$).

We examined the STarT-G scores among participants with known differences. As expected, participants with more somatic symptoms had significantly higher STarT-G scores. The mean score was 0.97 (1.12), 1.96 (1.42), and 2.74 (1.53) in participants with zero, one, and two or more somatic symptoms, respectively (Figure 4). This linear trend of increasing total STarT-G score with an increasing number of somatic symptoms was highly significant (Jonckheere–Terpstra test, $P < 0.0001$). Furthermore, participants with pain at a higher number of body sites had significantly higher STarT-G scores. The mean score was 0.63 (1.05), 1.05 (1.25), 1.27 (1.30), 1.50 (1.37), 1.80 (1.45), 2.23 (1.54), and 2.96 (1.57) in participants with zero, one, two, three, four-to-five, six-to-nine, and ≥10 pain sites, respectively (Figure 5). This linearly increasing trend in STarT-G score with an increasing number of bodily pain sites was highly significant (Jonckheere–Terpstra test, $P < 0.0001$).

The ability of the model to predict the presence of a DCP was also examined when the STarT-G threshold was set to 4. At this cutoff value, sensitivity and specificity for detecting a DCP were 65.8% and 82.4%, respectively. Additionally, area under the ROC curve was 0.808 for this STarT-G threshold, indicating that the model was good (Figure 6).

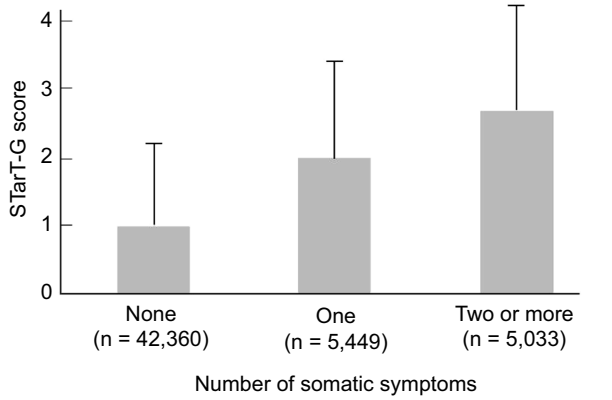

Figure 4 Mean STarT-G scores for participants with different numbers of somatic symptoms.
Notes: The linear trend was found to be highly significant (Jonckheere–Terpstra test, $P < 0.0001$). The STarT-G is the generic version of the STarT Back 5-item screening tool. The number of somatic symptoms was determined using the Brief Symptom Inventory somatization scale.

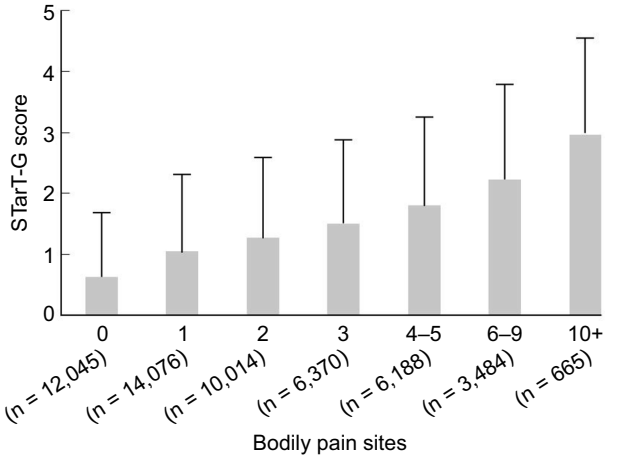

Figure 5 Mean STarT-G scores for participants with different numbers of pain sites.
Notes: The linear trend was found to be highly significant (Jonckheere–Terpstra test, $P < 0.0001$). The STarT-G is the generic versions of the STarT Back 5-item screening tool. The number of pain sites represents pain experienced during the past month in the head, chin, teeth/mouth, face, throat, neck, shoulder, elbow, wrist/hand, chest, abdomen, back, low back, hip, thigh, knee, lower leg, ankle/foot, genitals, and/or anus.

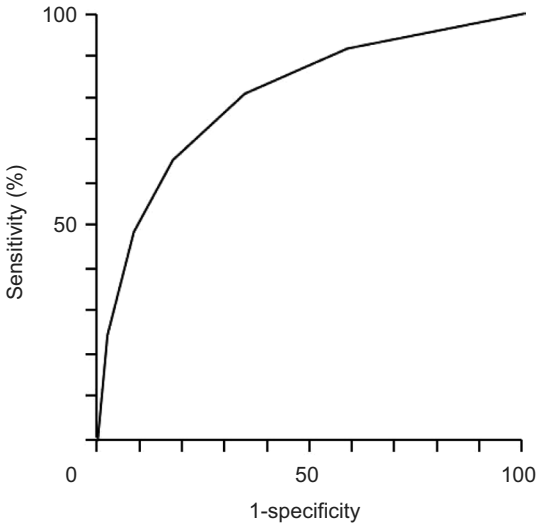

Figure 6 Receiver operating characteristics (ROC) curve of disability due to chronic pain, as assessed using a STarT-G score threshold value of 4.
Note: The area under the ROC curve was 0.808.

Discussion

Here, we evaluated psychometric properties of the STarT-G. We found that the survey was internally consistent and had acceptable concurrent and known-groups validity in the Japanese population. The Cronbach's alpha coefficient for the STarT-G was 0.71, indicating a good internal consistency. This value was similar to that obtained for the Japanese 9-item STarT scale (0.75).[13] Concurrent validity was assessed by analyzing correlations between the STarT-G and pain NRS scores, which were moderately correlated with each other ($r = 0.34$). Known-group validity was investigated by examining relationships between STarT-G scores and the number of somatic symptoms and body pain sites. These analyses showed that the STarT-G score increased as the number of somatic symptoms and pain sites increased. This suggests that the STarT-G is able to differentiate between patients with different levels of chronic pain and pain-related problems.

Yellow flags are useful in identifying patients with chronic LBP who have a poor prognosis.[22] The 5-item tool covers the minimal important psychological factors that are considered to be yellow flags for overall chronic LBP. This survey includes questions related to fear, anxiety, catastrophizing, depression, and bothersomeness, all of which are the most important predictors identified as yellow flags. For patients with high STarT-G scores, specific cognitive behavioral approaches are needed in addition to pain education, motivation, encouragement, exercise, medical therapy (minimal amounts), and physical treatment. This conclusion is based on previous reports that stated, "early intervention to yellow flag leads to better outcome."[23,24]

Finally, ~1.5% of participants reported having a DCP. At a STarT-G threshold value of 4 points, ROC analysis revealed that the sensitivity and specificity of DCP were 65.8% and 82.4%, respectively. Additionally, the AUC was 0.808, indicating a good capacity of the STarT-G to differentiate between patients with and without a DCP.

The STarT-G is a diagnosis-specific screening tool used for communication between primary care physicians and pain specialists in the care of chronic pain patients. Using the STarT-G threshold of 4 points, patients examined here were divided into the following two groups: those at risk for a DCP and those with minimal to no risk for a DCP. We recommend that patients at or beyond this threshold consult a pain specialist. The STarT-G is now planned to be used as a tool to identify patients for referral to one of 18 core facilities in Japan that provide cognitive behavioral therapy.

Our study had several limitations. First, our study population was selected from Internet research volunteers who have chronic pain. Given that 41% of participants had a STarT-G score of 0, many patients may have had chronic pain that was not severe enough to require medical care. This may have influenced our results. Second, Internet-based surveys can introduce a selection bias and may not be representative of the general population. Because our study population was selected from Internet research volunteers who may differ from general Internet users, caution is needed when interpreting our study findings. In particular, people living in large cities are overrepresented in Internet survey company volunteers. In addition, a higher proportion of respondents had completed university or graduate level education than the general population, particularly in older respondents.[25] Third, our study had a test reliability of >0.70.[19] However, Nunnally and Bernstein[26] recommend a minimum test reliability of >0.90 for making clinical decisions. Therefore, it is possible that test reliability was overestimated. Finally, this cross-sectional study did not assess the ability of the STarT-G to predict pain consistency. Future longitudinal studies are needed to better understand potential associations between risk groups and long-term pain outcomes. These should also examine whether or not the STarT-G score is predictive of DCP.

Conclusion

The STarT-G scale had acceptable internal consistency, reliability, and validity (concurrent and known groups) in Japanese patients with chronic pain. We hope that these analyses of the psychometric properties of STarT-G will enable Japanese clinicians to use this survey as a screening tool for detecting DCPs. The STarT-G is simple, fast, and suitable for use in primary care settings, all of which suggest that the STarT-G may facilitate screening for DCP in the primary care setting in Japan. We hope using the STarT-G will ultimately ease physical, social, and economical burdens of chronic pain in the Japanese population.

Disclosure

The authors report no conflicts of interest in this work.

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RESEARCH ARTICLE

Prognostic psychosocial factors for disabling low back pain in Japanese hospital workers

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Abstract

Background

Although the occupational health field has identified psychosocial factors as risk factors for low back pain that causes disability, the association between disabling low back pain and psychosocial factors has not been examined adequately in Japanese hospital workers. Therefore, this study examined the association between low back pain, which interfered with work, and psychosocial factors in Japanese hospital workers.

Method

This cross-sectional study was conducted at a hospital in Japan. In total, 280 hospital workers were recruited from various occupational settings. Of these, 203 completed a self-administered questionnaire that included items concerning individual characteristics, severity of low back pain, fear-avoidance beliefs (Fear-Avoidance Beliefs Questionnaire), somatic symptoms (Somatic Symptom Scale-8), psychological distress (K6), workaholism, and work-related psychosocial factors (response rate: 72.5%). Logistic regression was used to explore risk factors associated with disabling low back pain.

Results

Of the 203 participants who completed questionnaires, 36 (17.7%) reported low back pain that interfered with their work. Multivariate analyses with individual factors and occupations adjusted for showed statistically significant associations between disabling low back pain and fear-avoidance beliefs (adjusted odds ratio [OR]: 2.619, 95% confidence interval [CI]: 1.003–6.538], somatic symptoms (OR: 4.034, 95% CI: 1.819–9.337), and interpersonal stress at work (OR: 2.619, 95% CI: 1.067–6.224).

Conclusions

Psychosocial factors, such as fear-avoidance beliefs, somatic symptoms, and interpersonal relationships at work, were important risk factors in low back pain that interfered with work in

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Japanese hospital workers. With respect to occupational health, consideration of psychosocial factors is required to reduce disability related to low back pain.

Introduction

Low back pain (LBP) is an extremely common global health problem [1] and one of the main causes of disability in working populations [2]. According to the Global Burden of Disease Study conducted in 2013, which was an international collaborative effort led by the Institute for Health Metrics and Evaluation to quantify the absolute and relative burden of ill health and estimate prevalences and years lived with disability for 301 diseases and injuries, LBP was the leading cause of disability [3]. LBP is also considered a socioeconomic problem in the occupational health field [4–7]. A previous study examining the economic impact of various health conditions on work performance in Japanese workers indicated that LBP was one of the primary health conditions leading to work loss [8]. In addition, a large-scale survey examining LBP prevalence and associated factors in the Japanese adult population showed that one in four workers had been absent from work or other activities because of LBP [9]. The number of workers who were absent from social activities for at least 4 consecutive days has increased annually in the public health and hygiene fields [10]; therefore, the establishment of effective methods for the prevention of LBP in the workplace is urgently required.

In contrast, the understanding and interpretation of LBP is commonly based on the biopsychosocial model, and the importance of both psychosocial and biomedical factors has been emphasized in the development and persistence of LBP [11–13] In addition, the occupational health field has shown that psychosocial aspects of work play an important role in LBP chronicity and LBP-related disability [14]. Of the psychosocial factors related to LBP, fear-avoidance beliefs (FABs) in the management of LBP have received considerable global attention [15–17]. In addition, work-related psychosocial factors [18–23], such as job satisfaction, worksite support, interpersonal stress, workaholism, and a tendency toward somatization [24], have been associated with the development of LBP. However, few studies have examined the relationship between LBP and psychosocial factors in Japanese public health service workers systematically. The aim of this cross-sectional study was to explore LBP in medical and non-medical hospital workers and perform a systematic examination of the association between psychosocial factors and LBP with disability.

Materials and methods

Study population

Cross-sectional data collected from the baseline survey of the Yoseikai Study, an occupational cohort study conducted in Japan, were used in the current study.

The research ethics committee for the Graduate School of Medicine and Faculty of Medicine at the University of Tokyo (No. 1264) and the Incorporated Medical Institution Yoseikai reviewed and approved the study's aim and procedure. Written informed consent was obtained from all participants prior to the initiation of the study.

In March 2015, all of the employees at a Japanese hospital (N = 280) were recruited via an invitation letter from the authors. The survey was conducted during May 2015. During the survey period, occupational health staff at the hospital distributed a nonanonymous, self-administered questionnaire to each employee. Once the employees had completed the questionnaires, they placed them in sealed envelopes, which occupational health staff collected and

forwarded to the authors. All employees were assured that their participation was voluntary, and supervisors and occupational health staff were not authorized to open the sealed envelopes. In total, 203 employees completed the self-administered questionnaire.

Study measures

The questionnaire included questions regarding the following: individual characteristics including sex, age, body mass index (BMI), and occupation type; LBP severity; and individual and work-related psychosocial factors. LBP severity was evaluated by the respondents, who were asked to indicate the severity of their LBP according to four grades (0 = no LBP, 1 = LBP that did not interfere with work, 2 = LBP that interfered with work, and 3 = LBP that interfered with work and required sick leave). The grades were determined with reference to Von Korff's grading method [25]. LBP was defined as pain in the lower back lasting for more than 1 day and experienced during the preceding 4 weeks, according to the standard definition of LBP proposed by Dionne et al. [26]. Pain associated with menstruation or pregnancy or experienced during a feverish illness was excluded. A diagram showing the lower back area (between the inferior costal margin and gluteal folds [11]) was included in the questionnaire. LBP with disability was defined as LBP that interfered with work, regardless of work attendance (Grade 2 or 3), because presenteeism, or working while unwell, can lead to productivity loss and poor health.

The questions concerning current occupation type pertained to job satisfaction, job demand, job control, interpersonal stress at work, and social support. Work-related stress was assessed using the Brief Job Stress Questionnaire [27,28], which was developed by a research working group established by the Japan Labour, Health and Welfare Organization. The scale contains 57 items measuring psychosocial work environments, stress reactions, and buffering factors, with responses provided using a four-point Likert scale ranging from 1 to 4, with reverse scoring applied to some items. Total scores range from 57 to 228, and higher scores indicate greater work-related stress. The five original responses were reclassified as "not stressed," which included low, slightly low, and moderate stress, and "stressed," which included slightly high and high stress [20,23].

We evaluated mental health problems using the Kessler Screening Scale for Psychological Distress (K6), which was developed in 2002 as a short-form version of the K10 [29]. The scale measures psychological distress experienced during the preceding 30 days, using six items, with responses provided using a five–point scale ranging from 0 (all of the time) to 4 (none of the time) or ranging from 1 (all of the time) to 5 (none of the time). The Japanese version of the scale was developed by Furukawa et al. in 2008 and demonstrated reliability and validity [30]. Respondents were classified into three groups according to their total scores ($\geq$10 = high, 5–9 = moderate, and $\leq$4 = low).

Somatic symptom burden was measured using the Somatic Symptoms Scale-8 (SSS-8), which is an abbreviated eight-item version of the Patient Health Questionnaire-15. We used the linguistically validated Japanese version of the SSS-8, which was developed in our previous study [31]. The scale measures the extent to which respondents have been bothered by somatic symptoms during the preceding 7 days, with responses provided using a five-point Likert scale ranging from 0 (not at all) to 4 (very much). Total scores range from 0 to 32 and represent somatic symptom severity, with $\geq$16 points indicating very severe symptoms [32].

Participants' beliefs and fears were measured using the Fear-Avoidance Beliefs Questionnaire (FABQ), which was developed by Waddell et al. [33] and consists of 16 self-reported items. We used the Japanese version of the FABQ, which was developed and validated recently by Matsudaira et al. [34]. The study used the FABQ's four-item physical activity subscale

(FABQ-PA), which measures respondents' beliefs about the effects of physical activity on their LBP. Responses are provided using a seven-point Likert scale ranging from 0 (completely disagree) to 6 (completely agree). Total scores range from 0 to 24, and higher scores represent higher FAB levels. Participants' scores were classified into two categories ($\leq$14 = low, $\geq$15 = high) [35].

Workaholism, which has been associated with psychological health, was measured using the Dutch Workaholism Scale [36], which consists of two subscales: working excessively and working compulsively. Each subscale consists of five items, with responses provided using a four-point Likert scale ranging from 1 (totally disagree) to 4 (totally agree). Respondents were classified into three groups according to their total scores (high, moderate, and low) [21].

Statistical analysis

We performed logistic regression analysis, as our dependent variable "presence or absence of chronic pain" was dichotomous. One set of guidelines suggested that accurate estimation of discriminant function parameters requires a sample size of at least 20 for each independent variable in logistic regression [37]. In addition, the prevalence rates for chronic pain reportedly range from 10% to 55% [38]. Therefore, we calculated an overall sample size of 200 to ensure that there were 20 participants, even with a minimum prevalence rate of 10% for chronic pain.

Demographic and clinical characteristics were compared using Student's t test for continuous variables and chi-square tests for categorical variables. Factors associated with LBP were assessed using multivariable logistic regression analysis. Risk factors included job satisfaction; job demand; job stress; job control; social support from a supervisor/manager, colleagues, or family; K6 score; SSS-8 score; workaholism score; and FABQ-PA score. Because of the relatively low number of participants with back pain in the study, propensity score adjustment was used for each of the risk factors in multivariate modeling.

Propensity score adjustment preserved statistical power by reducing covariates into a single variable. For example, when the adjusted effect of LBP was evaluated, a propensity score was created using binary logistic regression to predict the probability of LBP as a function of the important factors (sex, age, BMI, occupation type [medical or nonmedical]) included in the study. Data analysis was performed using SAS software (version 9.4, SAS Institute Inc., Cary, NC).

Results

Participants' characteristics are shown in Table 1. Their mean age was 39.8 (SD = 12.2) years, and 70% of the participants were women. Most (63.1%) participants' occupation types were classified as medical, and their mean BMI score was 22.6 (SD = 4.1).

Of the 203 participants who responded to the questionnaires, 36 (17.7%) reported LBP that interfered with their work. The results of the comparison of characteristics between participants with and without LBP are shown in Table 2. Participants without LBP (mean age = 44.3, SD = 10.4 years) were significantly older relative to those with LBP (mean age = 38.8, SD = 12.3 years, p = .013). BMI did not differ significantly between participants with (M = 22.9, SD = 4.4) and without LBP (M = 22.5, SD = 4.0; p = .590). FABQ-PA scores (p = .037), SSS-8 scores ($p < .001$), and interpersonal stress at work (p = .022) in participants with LBP that did not interfere with work were significantly higher relative to those observed in those with LBP that interfered with work.

These three variables were extracted from the multiple logistic regression model as significant independent factors, with age, sex, BMI, and occupation type controlled for (Table 3). FABQ-PA scores (adjusted odds ratio [AOR] = 2.619, 95% confidence interval [CI]: 1.003–

Table 1. Participant characteristics (N = 203).

		n (%)
Sex	Male	61 (30.0)
	Female	142 (70.0)
Occupation type	Medical	128 (63.1)
	Nonmedical	75 (36.9)
FABQ-PA score	Low	172 (85.6)
	High	29 (14.4)
Job satisfaction	Dissatisfied	51 (26.2)
	Satisfied	144 (73.8)
Job demand	Not stressed	126 (62.7)
	Stressed	75 (37.3)
Interpersonal stress at work	Not stressed	163 (81.5)
	Stressed	37 (18.5)
Job control	Control	147 (72.8)
	No control	55 (27.2)
Support from supervisors	Supported	114 (57.6)
	Unsupported	84 (42.4)
Support from coworkers	Supported	151 (75.9)
	Unsupported	48 (24.1)
Support from family and friends	Supported	58 (29.1)
	Unsupported	141 (70.9)
K6 score	Low	103 (50.7)
	Moderate	54 (26.6)
	High	46 (22.7)
SSS-8 score	Other	128 (64.0)
	Very high	72 (36.0)
Workaholism score	Low	63 (31.2)
	Moderate	73 (36.1)
	High	66 (32.7)

BMI: body mass index; FABQ-PA: Fear-Avoidance Beliefs Questionnaire-Physical Activity; LBP: low back pain; SD: standard deviation; SSS8: Somatic Symptom Scale-8

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6.538), SSS-8 scores (AOR = 4.034, 95% CI: 1.819–9.337), and interpersonal stress at work (AOR = 2.619, 95% CI: 1.067–6.224) were significantly associated with LBP that interfered with work.

Discussion

This cross-sectional study examined the association between psychosocial factors and LBP that interfered with Japanese medical and nonmedical workers' ability to work at a hospital. In the multiple logistic regression analysis, in which age, sex, BMI, and occupation type were controlled for, fear-avoidance beliefs, the tendency toward somatization, and interpersonal stress at work were significantly associated with LBP that interfered with work. This was the first study to demonstrate an association between fear-avoidance behavior and LBP with disability in Japanese medical and nonmedical hospital workers.

The prevalence rates for LBP in a previous study [38] that compared chronic pain prevalence rates between various countries were 13%, 6%, and 1.48% for Japan, Thailand, and Myanmar, respectively. These results showed that, in the Asian region, the prevalence of LBP

Table 2. Comparison of characteristics between participants with and without LBP.

Factors		With LBP (n)	Without LBP (n)	p value
n		36	167	
Sex	Male	15	46	.094
	Female	21	121	
Occupation type	Medical	26	102	.209
	Nonmedical	10	65	
FABQ-PA score	Low	26	146	.037
	High	9	20	
Job satisfaction	Dissatisfied	10	41	.634
	Satisfied	24	120	
Job demand	Not stressed	19	107	.258
	Stressed	16	59	
Interpersonal stress at work	Not stressed	23	140	.022
	Stressed	11	26	
Job control	Control	26	121	.825
	No control	9	46	
Support from supervisors	Supported	21	93	.440
	Unsupported	12	72	
Support from coworkers	Supported	28	123	.333
	Unsupported	6	42	
Support from family and friends	Supported	10	48	.970
	Unsupported	24	117	
K6 score	Low	18	85	.794
	Moderate	11	43	
	High	7	39	
SSS-8 score	Other	13	115	.0003
	Very high	22	50	
Workaholism score	Low	10	53	.678
	Moderate	12	61	
	High	14	52	

BMI: body mass index; FABQ: Fear-Avoidance Beliefs Questionnaire-Physical Activity; LBP: low back pain; SD: standard deviation; SSS8: Somatic Symptom Scale-8

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was particularly high in Japan, which is an advanced country. This could reflect differences in cultural backgrounds, which included psychosocial factors. In addition, Sakakibara's study [38] defined LBP as chronic pain, while the current study defined it as LBP with disability. However, considering that LBP is the most common type of chronic pain, the prevalence rate for LBP in workers with medical occupations, including nursing, in the current study (17.7%) was similar to that observed in Sakakibara's study [38], and this is a reasonable result.

The current study examined the association between psychosocial factors and LBP that interfered with work, regardless of sick leave. The cost of work loss resulting from a combination of absenteeism and presenteeism due to back disorders was higher relative to that observed for various other health conditions in Japan [8]. In addition, the estimated cost of work loss resulting from presenteeism due to back pain was higher relative to that resulting from absenteeism due to back pain. Our previous international epidemiological study [24] showed that, relative to British workers, Japanese workers were less likely to take sick leave because of musculoskeletal disorders, particularly LBP. Therefore, in our assessment of LBP in

Table 3. Multiple logistic regression analysis of associations between LBP that interfered with work and independent variables.

Factors		Adjusted OR	95% CI	p value
Job satisfaction		1.027	0.436–2.591	.952
Job demand		1.593	0.720–3.503	.248
Interpersonal stress at work		2.619	1.067–6.224	.036
Job control		0.888	0.3549–2.062	.788
Support from supervisors		0.774	0.331–1.743	.539
Support from coworkers		0.645	0.223–1.625	.366
Support from family and friends		1.002	0.439–2.421	.995
K6 score	Moderate vs. High	0.599	0.184–1.821	.368
	Low vs. High	0.881	0.303–2.342	.805
	Low vs. Moderate	1.471	0.579–3.637	.408
SSS-8 score		4.034	1.819–9.337	< .001
Workaholism score	Low vs. Moderate	1.133	0.416–3.121	.805
	Low vs. High	1.453	0.576–3.783	.429
	Moderate vs. High	1.282	0.505–3.324	.600
FABQ-PA score		2.619	1.003–6.538	.049

Adjusted for age, sex, body mass index, and occupation type. CI: confidence interval; FABQ-PA: Fear-Avoidance Beliefs Questionnaire-Physical Activity; LBP, low back pain; OR: odds ratio; SSS8: Somatic Symptom Scale-8

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Japanese workers, we defined LBP with disability as LBP that interfered with work, regardless of whether sick leave was taken.

Relationship between FAB and LBP with disability

The fear-avoidance model has been proposed as a representative type of thought process involving the chronicity of LBP. FABs in LBP are negative beliefs and anxiety regarding LBP, which lead to a catastrophizing response in which the worst possible outcome is imagined, causing fear and avoidance of activity and resulting in functional restriction. Of the psychological factors examined as prognostic factors for the development of chronic LBP, FABs have been shown to constitute an important factor and exerted a strong effect on employment conditions and disability prognoses [39]. The introduction of a psychosocial flag system to manage musculoskeletal problems, including LBP, in healthcare and the workplace has been suggested in Western countries. Within this concept, FABs are represented by a yellow flag, and some researchers have recommended that clinical practitioners should judge the involvement of FABs during the early stages of pain and manage them in cooperation with the patient's workplace [40]. Some studies have shown that FABs led to a tendency toward development of chronic LBP with disability [41–43]. In the present study, the results indicated that FABs were related to LBP in Japanese public health service workers. As a significant independent factor in multiple logistic analysis with certain variables controlled for, FABs were an important factor and should be considered in the management of LBP. In addition, early intervention is important in increasing awareness of FABs in patients with disabling LBP in Japan.

Relationship between somatic symptoms and LBP with disability

The tendency toward somatization is defined as a predisposition to excessive worry regarding common somatic symptoms, such as headaches, dizziness, and stomach or bowel problems, which could be triggered by mental distress. This tendency has been shown to affect various health conditions (via related behaviors), musculoskeletal pain (particularly multisite pain)

[44], and absence from work [45]. The relationship between pain and the tendency toward somatization has been observed in both longitudinal and cross-sectional studies, indicating that this tendency is a predictor, rather than a consequence, of other aspects of health [46].

The tendency toward somatization has been associated with [15,46–48] and identified as a major risk factor for LBP[24]. The association between chronic LBP with disability and a combination of psychosocial factors could be explained by dysfunction in the mesolimbic dopamine system, which controls both pain and pleasure [49,50] When a person experiences painful stimuli, the mesolimbic dopamine system is activated to inhibit pain. However, exposure to chronic, rather than acute, stress, such as anxiety or distress, has recently been suggested to result in hyperalgesia because of the inhibition of mesolimbic dopamine mechanisms. For example, hyperalgesia resulting from chronic stress because of discontentment with life and work could lead to the development of chronic LBP with disability [51]. The results of the current study indicated that the tendency toward somatization was associated with LBP that interfered with work. This could indicate LBP should be managed as brain dysfunction as well as musculoskeletal disease.

Relationship between interpersonal stress at work and LBP with disability

The relationship between interpersonal stress at work and occupational LBP has attracted attention for some time [18]. In particular, stressful, monotonous work was identified as a predictive factor for new-onset LBP in a cohort study [52]. In addition, a recent 2-year prospective epidemiological study involving 5,310 workers in Japan suggested that work-related stress affected the onset and persistence of LBP with disability [20]. The way in which psychological factors cause LBP remained unclear in the current study; however, two biomechanical (ergonomic) studies showed that psychological stress increased low back compression force during lifting tasks [53,54], which could indicate that stress is associated with increased risk of LBP development. Our results suggested that interpersonal stress at work is an important factor in understanding occupational LBP.

The results showed that fear-avoidance beliefs regarding LBP, which has been recognized worldwide as an important risk factor; the tendency toward somatization, which is a type of stress response; and interpersonal stress at work were associated with LBP with disability in medical workers. According to the results, pain education based on the biopsychosocial model could be inadequate in Japan, even for medical personnel. A recent systematic review examining LBP prevention indicated that exercise combined with education was likely to reduce the risk of LBP [55]. Ergonomic factors and the psychosocial factors examined in the current study should be considered in education regarding LBP prevention.

The present study was subject to some limitations. First, it was conducted at a single hospital; therefore, the generalization of the results is limited. Second, the number of participants with LBP that interfered with their work was low; however, we dealt with this problem statistically using propensity score adjustment. Third, the study was cross-sectional in design; therefore, causation could not be inferred. We plan to conduct an additional cohort study to examine causal associations. Fourth, various chronic pain conditions interfere with work, but the current study considered only LBP. Future research should examine the effects of chronic pain in various parts of the body and compare them to those observed for LBP. Fifth, the results showed that LBP was affected by individuals' personal relationships; however, the study did not consider factors examined in previous studies (e.g., family environment, nursing, and genetic predisposition).

In conclusion, the results of the present study suggested that psychosocial factors, such as FABs, the tendency toward somatization, and interpersonal stress at work were associated

with LBP that interfered with work. Future preventive strategies for reducing LBP in the workplace should include not only biomechanical factors, which are already well understood, but also the management of psychosocial factors.

Supporting information

S1 File. Supporting information. Dataset of this study.
(XLSX)

Author Contributions

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RESEARCH ARTICLE

Sagittal spino-pelvic alignment in adults: The Wakayama Spine Study

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Data Availability Statement: The present study used resident data from two communities in Wakayama prefecture. It is impossible for us to provide and upload these data in a public repository because we have confirmed with these municipalities and residents that data will remain confidential. We will provide anonymized data on request after discussing the contents with the municipalities, as long as researchers are qualified to request these data. Data requests can be made to the corresponding author at stsutsui1116@gmail.com. Data are managed by one of the co-authors, Hiroshi Hashizume. Data

Abstract

Objectives

To establish the normal values of spino-pelvic alignment and to clarify the effect of age-related changes using large, community-based cohorts.

Methods

In this study, data from 1461 participants (466 men, 995 women) were analyzed. On lateral standing radiographs, the following parameters were measured: thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI), and C7 sagittal vertical axis (SVA). All values are expressed as the mean±standard deviation. The Spearman rank correlation coefficient was used to examine correlations between variables of spino-pelvic parameters. Finally, we analyzed the relationship between age and spino-pelvic parameters. Therefore, we entered values for the body mass index (BMI), SVA, TK, and PI-LL into a multiple regression model to adjust for potential confounding factors.

Results

The SVA, TK, and PT increased with age, and LL decreased with age. Regarding sex differences, the TK was statistically significantly larger in men than in women, and LL, PT, and PI were statistically significantly smaller in men than in women. Correlation coefficients between the SVA and TK, between the SVA and PI-LL, and between TK and PI-LL were none, strong, and weak, respectively. Results of multiple regression analysis between age and spino-pelvic parameters showed that the standardized partial regression coefficients for the SVA, TK, and PI-LL were 0.17, 0.30, and 0.23, respectively, in men and 0.29, 0.32, and 0.23, respectively, in women.

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Conclusions

We found that all parameters were significantly associated with age in men and women. The SVA, TK, and PT increased with age, and LL decreased with age. Results of multiple regression analysis also demonstrated that the SVA, TK, and PI-LL are related to age. Indeed, the PI-LL value increased with age. In this study, a more excessive PI-LL mismatch was shown, indicating an increased risk of spinal malalignment. Differences in the absolute values of spino-pelvic parameters in each sex were small yet statistically significant. Thus, further study should be performed to corroborate this finding.

Introduction

Sagittal spino-pelvic malalignment is one of the most prevalent disorders of the aging spine. Sagittal malalignment concerns are reflected in reports of flat back syndrome, which is an iatrogenic malalignment after spinal instrumentation that results in persistent lower back pain [1–4]. The sagittal curvature of the spine and pelvis balance each other to maintain a stable posture and horizontal gaze. Once the sagittal alignment is abnormal, more energy is required so that the body can remain balanced without external support [5]. Glassman et al. reported that positive sagittal balance was significantly related to clinical symptoms and health-related quality of life in patients with adult spinal deformity [6]. In addition, patients with kyphosis often complain of decreased walking ability and an increased propensity of falling, thereby resulting in weaker back extensor strength and poorer balance as well as heartburn due to gastroesophageal reflux disease, dysphasia, and respiratory symptoms [7–9]. Therefore, abnormal sagittal spinal alignment should be restored to normal. In previous studies, the C7 plumb line was used to measure sagittal global alignment [10–14]. The C7 sagittal vertical axis (SVA) is measured as the distance from the C7 plumb line to the posterosuperior endplate of the sacrum. The C7 plumb line has been used by previous authors to evaluate possible changes in sagittal spinal global alignment that occur with age. Increasing age was shown to correlate with increasingly anterior positions of the C7 plumb line [10, 11, 15]. Fon et al. [16] and Schwab et al. [15] proposed that the incidence of thoracic kyphosis (TK) increases with age. Youngbae et al. [17] hypothesized that the increase in TK is a fundamental change that occurs during aging. However, other studies [10, 11] did not support this hypothesis. Gelb et al. [11] reported that TK did not correlate with age in healthy older individuals, despite significant losses in lumbar lordosis (LL) and SVA. The pelvic incidence (PI) is unique to each individual and independent of the spatial alignment of the pelvis. The PI reflects the anatomy of the pelvis and does not change with pelvic or spine positioning [10, 18–21]. PI is an important anatomic parameter that reflects the anatomic configuration of the pelvis and greatly affects sagittal spino-pelvic alignment (SSPA). PI-LL has been considered to be a useful indicator in intraoperative planning of lumbar deformity operation [19, 22, 23]. PI-LL is significantly correlated with clinical parameters. Schwab et al. recommend that PI-LL should be corrected to less than 10˚ to achieve successful, harmonious spino-pelvic realignment in corrective operation of spinal deformity [19].

Recently, it has become possible to achieve optimal spinal alignment with the development of spinal operation techniques. There have been some reports regarding the normal values of SSPA [11, 24–27]. In addition, the optimal postoperative SSPA can be evaluated during preoperative surgical planning of spinal realignment based on these reported parameters [19, 28].

However, most of our previous studies were performed using Caucasian populations in the United States and European countries. The effect of ethnicity on skeletal growth has been demonstrated by previous studies [29, 30]. Age and sex are also reported to be associated with spino-pelvic alignment [31, 32]. Recently, some studies were conducted to evaluate the normal SSPA in Asian populations [33–35]. However, the number of participants was small, and only young adults were evaluated in these studies. The present study sought to establish the normal values of spino-pelvic alignment and to clarify the impact of age-related changes using large, community-based cohorts.

Materials and methods

Participants

Under the approval of our institutional review board, the present study, titled the Wakayama Spine Study, was performed with a sub-cohort of the third visit of the Research on Osteoarthritis/Osteoporosis Against Disability (ROAD) study, which was initiated as a nationwide, prospective study of bone and joint diseases in population-based cohorts. A detailed profile of the ROAD cohort has been previously reported [36, 37]. In brief, subjects included participants of the third visit of the ROAD study, which began in 2012 and completed in 2013. In addition to the former participants, inhabitants of the mountainous and coastal areas in the Wakayama prefecture who were willing to participate in the ROAD survey were also included in the third visit. Overall, 1575 individuals (513 men, 1062 women) participated in the third visit of the ROAD study. Among 1575 participants, 114 individuals who could not maintain a standing position while undergoing total lateral whole-spine radiography or had other disqualifiers were excluded. Finally, lateral whole-spine radiographs were available for 1461 participants (466 men, 995 women).

Participants were divided into five groups based on birth-year decade: (1) less than 50 years, (2) 50–59 years, (3) 60–69 years, (4) 70–79 years, and (5) 80 years and older. All individuals provided written informed consent.

Radiographic evaluation

All participants underwent radiography. For each subject, standing lateral radiography of the whole spine and pelvis was taken using 40-inch film. Each radiograph was aligned such that the edge of the film was the reference for vertical alignment. As described previously [34], participants were instructed to stand in a comfortable position, with their hips and knees fully extended. The arms were flexed with the hands resting on supports at the level of their shoulders.

On the radiographs, the following parameters were measured: TK (the Cobb angle from the upper endplate of T2 to the lower endplate of T12) [16], LL (the Cobb angle from the upper endplate of L1 to the lower endplate of S1) [23], pelvic tilt (PT) (the angle between the line connecting the midpoint of the sacral plate to the axis of the femoral heads and the vertical axis) [19], PI (the angle between the line perpendicular to the sacral plate at its midpoint and the line connecting this point to the axis of the femoral heads) [24], and SVA (the horizontal distance from the C7 plumb line originating at the middle of the C7 vertebral body to the posterior superior endplate of S1) [19].

Statistical analysis

Statistical analyses were performed using JMP (version 8; SAS Institute Inc., Cary, NC). All values are expressed as the mean ± standard deviation (SD). The Wilcoxon signed-rank test

was used to analyze the differences in spinal and pelvic parameters between men and women. The Spearman rank correlation coefficient (*r*) was used to examine correlations between variables of spino-pelvic parameters. The Spearman correlation coefficient was interpreted as follows: <0.3: none; 0.31–0.5: weak; 0.51–0.7: strong; 0.71–0.9: very strong; and >0.9: excellent. Finally, we analyzed the relationship between age and spino-pelvic parameters. Therefore, we entered values for the body mass index (BMI), SVA, TK, and PI-LL into a multiple regression model to adjust for potential confounding factors. The variance inflation factor (VIF) was used to check for multicollinearity in the model. The level of statistical significance was set at 0.05.

Results

Radiographic studies were completed for 1461 participants (466 men, 995 women) whose age range was 19–94 years (mean age: men, 66.3 ± 13.8 years; women, 65.2 ± 12.5 years). The average BMI was 23.0 ± 3.5 kg/m^2 (Table 1).

The mean value and SD of spino-pelvic parameters are listed in Tables 2 and 3. The SVA, TK, and PT increased with age, and LL decreased with age. Regarding sex differences, TK was significantly larger in men than in women, and LL, PT, and PI were significantly smaller in men than in women.

The correlation coefficients (*r*) between the SVA and TK, between SVA and PI-LL, and between TK and PI-LL were none (0.12), strong (0.54), and weak (-0.33), respectively (Table 4).

Table 5 shows the results from multiple regression analysis, after adjusting for various confounding factors. The VIF values in men for BMI, SVA, TK, and PI-LL were 1.04, 1.76, 1.45, and 2.13, respectively; those in women were 1.02, 2.27, 1.42, and 2.52, respectively. However, none of the VIF values exceeded 10, which indicates that there was no collinearity in the model [38]. On the basis of the results of this model, we found that all parameters were significantly associated with age in men and women. The standardized partial regression coefficients of SVA, TK, and PI-LL were 0.17, 0.30, and 0.23, respectively, in men and 0.29, 0.32, and 0.23, respectively, in women. PT had a high collinearity with other parameters, and it was excluded from Tables 4 and 5.

Table 1. Participants' demographic data.

	Total	Men	Women
Number of participants	**1461**	**466**	**995**
Age strata (years)			
≤49	170	56	114
50–59	256	75	181
60–69	418	124	294
70–79	407	123	284
≤80	210	88	122
Demographic characteristics			
Age (years)	65.6 ± 13.0	66.3 ± 13.8	65.2 ± 12.5
Height (cm)	156.0 ± 9.1	164.7 ± 7.3	151.8 ± 6.7
Weight (kg)	56.2 ± 11.1	64.2 ± 11.4	52.4 ± 8.7
BMI (kg/m^2)	23.0 ± 3.5	23.6 ± 3.4	22.8 ± 3.5

Values are presented as the mean ± standard deviation.
BMI, body mass index.

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Table 2. Spinal parameters.

	Sagittal vertical axis (mm)					Thoracic kyphosis (˚)					Lumbar lordosis (˚)				
Age	Men		Women			Men		Women			Men		Women		
(years)	Mean	SD	Mean	SD	p value	Mean	SD	Mean	SD	p value	Mean	SD	Mean	SD	p value
≤49	-11.0	22.9	-18.8	24.6	0.025*	33.5	7.2	33.1	9.3	0.757	47.9	9.1	52.0	10.3	0.013*
50–59	4.7	30.7	-8.2	25.6	<0.001*	36.0	9.2	34.2	10.6	0.192	45.2	9.5	48.9	10.4	0.007*
60–69	8.2	35.0	1.8	32.7	0.073	37.8	9.1	36.2	11.4	0.193	45.2	11.8	46.9	12.8	0.057
70–79	13.9	39.2	24.2	43.1	0.011*	41.6	11.8	38.9	12.7	0.038*	45.7	13.4	43.6	14.2	0.110
≤80	39.1	54.3	51.6	57.9	0.101	40.3	12.3	44.2	17.8	0.122	39.3	15.9	38.6	19.1	0.922
Total	12.7	41.3	10.1	43.4	0.062	38.5	10.7	37.2	12.8	0.022*	44.5	12.7	45.9	14.0	0.019*

SD, standard deviation

*Significant difference between men and women (p<0.05, Wilcoxon signed-rank test)

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Discussion

In this study, the SVA, TK, and PT increased with age, and LL decreased with age. In addition, the rate of increase in TK and decrease in LL was larger in women than in men, although the mean values of these parameters were within the generally accepted normal ranges [39–41].

Fon et al. reported that the degree of kyphosis increased with age, and the rate of increase was higher in women than in men [16]. This observation has been widely observed since increased TK is often related to osteoporotic compression wedging of the vertebrae, as well as to the degenerative change of intervertebral discs and decreased strength of back extensor muscles in the aged spine [42–51]. This degenerative change can also contribute to decreased LL [52]. Gelb et al. investigated 100 asymptomatic middle and older aged volunteers, and they found a correlation among the SVA, LL, and age [11]. These findings were supported by Hammerberg and Wood, whose study surveyed 50 asymptomatic volunteers aged 70–85 years [10]. The aforementioned correlation between spino-pelvic parameters and age may explain physiological aging of the spine. The center of gravity line moves forward in relation to increasing age [15], which may result in pain, functional disability, and loss of horizontal gaze due to the stooped posture. In an attempt to correct this position that interferes with the social standard of maintaining a horizontal gaze, the pelvis should be tilted backward [53].

The impact of sex on spino-pelvic parameters remains controversial. Vialle et al. reported significant differences in LL and PI between male and female subjects [27]. In addition, Zhu

Table 3. Pelvic parameters.

	Pelvic tilt (˚)					Pelvic incidence (˚)				
Age	Men		Women			Men		Women		
(years)	Mean	SD	Mean	SD	p value	Mean	SD	Mean	SD	p value
≤49	11.5	6.9	14.5	6.7	0.006*	46.0	9.9	51.0	10.8	0.002*
50–59	14.4	6.6	15.8	8.0	0.161	47.7	9.6	49.8	10.5	0.174
60–69	15.5	6.8	18.1	8.5	0.001*	48.3	9.9	50.6	10.4	0.028*
70–79	16.0	7.5	23.0	10.3	<0.001*	47.5	9.3	52.7	10.7	<0.001*
≤80	19.7	8.4	25.2	10.4	<0.001*	48.1	10.9	51.6	11.4	0.021*
Total	15.8	7.6	19.5	9.7	<0.001*	47.7	9.9	51.2	10.8	<0.001*

SD, standard deviation

* p<0.05

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Table 4. Correlation matrix among the spino-pelvic parameters.

Parameter	SVA	TK	PI-LL
SVA	1		
TK	0.12	1	
	<0.001*		
PI-LL	0.54	-0.33	1
	<0.001*	<0.001*	

Upper line, correlation coefficient; lower line, p-value. SVA, sagittal vertical axis; TK, thoracic kyphosis; PI, pelvic incidence; LL, lumbar lordosis

*Significant correlation between the parameters (p<0.05)

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et al. found a significant sex difference in LL [34]. Conversely, other researchers did not demonstrate significant sex differences in any spino-pelvic parameter [32, 33, 54]. Although there were statistically significant differences in TK, LL, PT, and PI between men and women in the current study, the difference in the mean value of each parameter was quite small. Additionally, the individual variations were much larger than were the sex differences. When considering clinically important differences, further study should be performed to corroborate this finding. Recently, there have been some reports to support racial differences in sagittal spino-pelvic parameters [30], and most of them have exaggerated the smaller PI and LL in Asian populations than in Caucasian populations [33–35]. However, our cohort did not have a significantly smaller PI than did the Caucasian population, which is consistent with the Japanese epidemiological study by Takeda et al.[55], which reported a PI of 55.8 ± 10.6. There may be regional differences in sagittal spino-pelvic parameters as well.

Therefore, there must be strong correlations among spino-pelvic parameters. Legaya et al. reported that PI is a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves, and it correlates with LL [24]. In addition, Mac-Thiong et al. demonstrated a moderate correlation ($0.3 \leq r < 0.5$) between TK and LL [56]. Our results also suggested strong correlations between the SVA and PI-LL, as well as weak correlations between TK and PI-LL. To achieve harmonized, spino-pelvic alignment in surgical planning for spinal deformity, the PI-LL value was used to determine the amount of correction needed. In a recent study, a more excessive PI-LL mismatch was shown to indicate an increased risk of spinal imbalance [23]. Results of multiple regression analysis also demonstrated that the SVA, TK, and PI-LL are related to age. Indeed, the PI-LL value increased with age.

A longitudinal study would be required to assess the age-related changes of the sagittal spino-pelvic parameters accurately. Moreover, evaluation of the alignment of the cervical spine and/or lower extremities should be included since they also definitively show age-related changes and affect spino-pelvic alignment.

Table 5. Results of multiple regression analysis between age and spino-pelvic parameters.

	Men		Women	
	Standardized partial regression coefficient	p value	Standardized partial regression coefficient	p value
SVA	**0.17**	**0.0015***	**0.29**	**<0.001***
TK	**0.30**	**<0.001***	**0.32**	**<0.001***
PI-LL	**0.23**	**0.0001***	**0.23**	**<0.001***

SVA, sagittal vertical axis; TK, thoracic kyphosis; PI, pelvic incidence; LL, lumbar lordosis

*Significant correlation between age and parameters (p<0.05)

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Recently, more researchers have focused on spino-pelvic alignment because of the increasing number of adult patients in the aging society with back pain related to spinal malalignment. However, to the best of our knowledge, the current study, compared to previous studies, makes use of the largest cohort (more than 1,500 volunteers) from general populations with a wide range of ages. In doing so, we were able to better understand age-related and sex-related normal values of spino-pelvic sagittal alignment, although the study was performed in limited districts. Thus, we believe that this study's findings may help improve the treatment of patients with adult spinal deformity.

Conclusions

We found that all parameters were significantly associated with age in men and women. The SVA, TK, and PT increased with age, and LL decreased with age. Additionally, a more excessive PI-LL mismatch was shown to indicate an increased risk of spinal malalignment. Results of multiple regression analysis also demonstrated that the SVA, TK, and PI-LL are related to age. Indeed, the PI-LL value increased with age.

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Original Article

Obesity and low back pain: a retrospective cohort study of Japanese males

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Abstract. [Purpose] This study evaluated whether obesity is a risk factor for low back pain, by using body fat percentage (%FAT) and body mass index (BMI) as indices of obesity among Japanese males. [Subjects and Methods] This study included 1,152 males (average age: 28.0 ± 4.6 years). BMI was calculated from subject's height and weight, and %FAT was estimated by the thickness of two parts of skin. Low back pain, drinking and smoking were surveyed using a self-administered questionnaire, and maximal oxygen uptake was measured by a submaximal exercise test using a cycle ergometer. [Results] A significant positive dose-response relationship was shown between %FAT and persistent low back pain prevalence. Similarly, a significant positive dose-response relationship was confirmed between BMI and persistent low back pain. [Conclusion] This study suggests that both high %FAT and BMI are risk factors for persistent low back pain.
Key words: Obesity, Low back pain, Epidemiology

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INTRODUCTION

Low back pain is a global health concern and the top condition impacting the "disability-adjusted life-years" metric[1)]. In addition, low back pain is currently the most common condition in Japan[2)], comprising 65% of chronic musculoskeletal pain symptoms and was ranked as the most common condition among males with subjective symptoms due to diseases and injuries in Annual Health, Labour and Welfare Report[3)]. Low back pain also affects not only the health of workers but also their productivity, and other problems, leading to negative economic effects[4, 5)].

In addition, being overweight and obese is a global health concern[6)]. Cardiovascular diseases, diabetes, and some cancers are the top three diseases affecting disability-adjusted life-years, which are thought to be caused by overweight/obesity[7)]. According to a Global Health Observatory report in 2014, among adults over the age of 18 years in 149 countries in the World Health Organization area, 39% are overweight and 13% are obese, accounting for over 50% of all adults[6)].

There have been several cohort studies related to low back pain and obesity[8–11)]. Previous longitudinal studies reported that overweight/obesity is a risk factor for low back pain. However, no long-term cohort studies have been conducted focus-

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ing on Asian populations, who exhibit lower levels of obesity compared with Western populations[7]. In addition, most studies conducted to date have used body mass index (BMI) as an index of obesity. However, as BMI does not consider overall body composition and a high BMI value can be attributed to people with both high fat and muscle mass; risk factors for low back pain may not be evaluated accurately from the perspective of body composition.

In this study, body fat percentage (%FAT) data was added as an index of obesity; using over 20 years of follow-up data for Japanese males, we conducted an exploratory assessment of the relationship between %FAT, BMI, and low back pain.

SUBJECTS AND METHODS

This study was one of the cohort studies investigating the relationship between obesity, physical fitness, and health outcomes in Japanese males[12, 13]. Participants in this study were employees of companies based in the greater Tokyo metropolitan area. All employees receive annual health examinations and exercise tests as part of employee health management plans implemented in accordance with the Occupational Safety and Health Act and related laws in Japan.

There were 8,638 participants in this study who underwent routine physical examinations and exercise tests in 1986 (April 1986–March 1987). Thirty people who failed to continue the exercise test for more than 4 min were excluded. In addition, 6,912 people for whom the presence of low back pain could not be determined as of 2009 because of retirement during the period between 1987 and 2008 were excluded, as well as 9 people for whom data that was considered to contain potential confounding factors that were missing were excluded. In addition, 536 people with low back pain at the time of baseline measurement in 1986 and who had experienced low back pain prior to 1986 were excluded. Ultimately, 1,152 males were enrolled as participants in this study.

In our observational study, the clinical examinations were done under the Industrial Safety and Health Act and related laws in Japan. This study was approved by the ethics committee of the National Institutes of Health and Nutrition of Japan (290-01).

Participants in this study were measured for height and weight at annual health examinations conducted in 1986. Body weight was measured using a body weight scale, with participants removing their shoes and wearing light clothing. Based on the results, BMI (weight (kg) divided by the square of height (m)) was determined. To estimate %FAT, the thickness of skin pinched at the posterior midpoint between acromion and tip of olecranon, and lower edge of the scapula was measured using a subcutaneous fat thickness-measuring device (TK-11258, Takei Scientific Instruments, Niigata, Japan). Total fat thickness of these two regions was inputted into Nagamine and Suzuki's equation to estimate body density[14]. Next, %FAT was estimated by inputting body density into Brozek's equation[15].

The results of the questionnaire regarding the presence of low back pain (none, in the past, present) were used to exclude participants (both in the past and present) with low back pain at baseline. Further, maximal oxygen uptake was used as an index of physical fitness and was considered a potential confounding factor of low back pain. This factor was adjusted during analysis to evaluate the relationship between obesity and low back pain. Maximal oxygen uptake was measured by a submaximal exercise test using a cycle ergometer and was estimated using the Åstrand and-Ryhming nomogram[16] and Åstrand age correction factors[17]. Additionally, lifestyles considered to present potential confounding factors, including smoking (nonsmoking, 1–20 cigarettes per day, 21 or more cigarettes per day) and alcohol intake (none, 1–20 g per day, 21 g or more per day), were evaluated.

We determined the presence or absence of "persistent low back pain" from the results of the self-administered questionnaire about low back pain (none, sometimes (intermittent), always (persistent)) in 2009. We defined participants who responded "always (persistent)" as persistent low back pain suffers.

First, we classified the participants by quartile based on their %FAT and BMI at baseline and compared the physical characteristics at baseline for each group. All data is displayed as the mean and standard deviation. The relationship between %FAT and BMI was confirmed using Pearson's correlation coefficient. Next, we used a logistic regression model to calculate the multivariable-adjusted odds ratio and the 95% confidence interval for persistent low back pain prevalence while taking potential confounding factors (age, alcohol intake, smoking habits, and maximal oxygen uptake) into account. Further, to examine the relationship between obesity and persistent low back pain prevalence, the odds ratio and 95% confidence interval of persistent low back pain prevalence were calculated using a logistic regression model with the presence or absence of persistent low back pain as a dependent variable and %FAT and BMI quartiles as independent variables. In the logistic regression model, age (continuous number) was input as a covariate, and the age-adjusted odds ratio and 95% confidence interval were calculated. In addition, multivariable-adjusted odds ratios and 95% confidence intervals were determined while considering smoking habits (nonsmoker, 1–20 cigarettes per day, 21 or more cigarettes per day), alcohol intake (none, 1–20 g per day, 21 g or more per day), and maximal oxygen uptake (continuous number). To evaluate whether a linear relationship existed between obesity and persistent low back pain prevalence, continuous numbers for %FAT and BMI were inputted into the model to calculate p for linearity.

Many previous studies evaluated relationships with low back pain using the WHO criteria for BMI. Therefore, to compare these studies with our study, we also conducted our assessment based on 4 categories: thin (<18.50), average (18.51–24.99), overweight (25.00–29.99), and obesity (≥30.00) according to WHO classification.

All statistical analyses were performed using SPSS Statistics version 23 (IBM Corp, Armonk, NY, USA), and a two-tailed

Table 1. Baseline characteristics of Japanese males in 1986 according to body fat percentage and body mass index (quartiles)

Characteristic	All men	Q1 (lowest)	Q2	Q3	Q4 (highest)
Body fat percentage (%)		≤12	13–14	15–17	≥18
n	1,152	335	282	295	240
Age (yrs)	28.0 ± 4.6	27.6 ± 4.8	27.9 ± 4.7	28.3 ± 4.5	28.2 ± 4.5
Body mass index (kg/m^2)	22.6 ± 2.7	20.8 ± 1.9	22.1 ± 2.0	23.1 ± 1.9	25.2 ± 3.0
VO_2max (ml/kg/min)	43.2 ± 8.9	46.5 ± 8.8	43.9 ± 8.2	42.2 ± 8.5	38.7 ± 8.3
Current drinkers (%)	64.1	60.0	61.0	67.5	69.6
Current smokers (%)	63.4	71.0	61.0	57.3	62.9
Body mass index (kg/m^2)		≤20.82	20.83–22.31	22.32–24.05	≥24.06
n	1,152	285	290	289	288
Age (yrs)	28.0 ± 4.6	27.1 ± 5.0	27.4 ± 4.4	28.7 ± 4.5	28.7 ± 4.4
Body fat percentage (%)	14.7 ± 3.5	12.3 ± 2.4	13.8 ± 2.5	15.2 ± 3.0	17.6 ± 3.7
VO_2max (ml/kg/min)	43.2 ± 8.9	46.5 ± 9.0	44.7 ± 8.6	43.3 ± 8.3	38.2 ± 7.6
Current drinkers (%)	64.1	59.3	59.0	69.6	68.8
Current smokers (%)	63.4	65.6	59.3	64.0	64.6

Data are means ± standard deviation or %
VO_2max: maximal oxygen uptake

Table 2. Multivariable-adjusted odds ratios for incidence of persistent low back pain by potential confounders

Characteristic	Participants	Odds Ratio[a]	95% CI
Age (yrs)	1,152	0.98	0.93–1.03
VO_2max (ml/kg/min)			
1st quartile ≤36	301	1.00 (reference)	
2nd quartile 37–42	285	1.22	0.68–2.20
3rd quartile 43–49	309	0.90	0.48–1.67
4th quartile ≥50	257	0.81	0.41–1.58
Alcohol intake			
None	413	1.00 (reference)	
1–20 g/day	517	0.73	0.44–1.22
≥21 g/day	222	1.19	0.66–2.15
Current smokers			
None	422	1.00 (reference)	
1–20 cigarettes/day	457	1.20	0.74–1.94
≥21 cigarettes/day	273	0.68	0.36–1.28

[a]Adjusted for all items in the table.
CI: confidence interval; VO_2max: maximal oxygen uptake

p value less than 0.05 was considered to be statistically significant.

RESULTS

In this study 1,152 people were recruited, and the average age, weight, and height at the time of baseline measurement (1986) were 28.0 ± 4.6 years, 65.5 ± 8.4 kg, and 170.0 ± 5.6 cm. The number of people who had persistent low back pain in 2009 was 90. Table 1 shows the physical characteristics of the participants at the baseline. The average %FAT and BMI as an index of obesity were 14.7 ± 3.5% and 22.6 ± 2.7 kg/m^2, respectively, and a clear positive correlation was found between %FAT and BMI (r=0.62). There was no correlation between %FAT and age; however, for BMI, the age of the 3rd and 4th quartiles was higher than that of the 1st and 2nd quartiles. Regarding maximal oxygen uptake, both %FAT and BMI showed lower values in the group tending towards obesity. In contrast, presence of current drinkers was higher in the group with obesity tendencies. No trends concerning smoking habits were observed.

Table 2 shows the multivariable-adjusted odds ratio and 95% confidence interval for persistent low back pain prevalence

Table 3. Multivariable-adjusted odds ratios for incidence of persistent low back pain according to body fat percentage and body mass index (quartiles)

	Q1 (lowest)	Q2	Q3	Q4 (highest)	p for linearity
Body fat percentage (%)	≤12	13–14	15–17	≥18	
n	335	282	295	240	
Men-years of follow-up	7,705	6,486	6,785	5,520	
Persistent LBP per 10,000 men-years	27	23	37	53	
Age-adjusted odds ratio (95% CI)	1.00 (reference)	0.85 (0.43–1.68)	1.41 (0.77–2.58)	2.10 (1.16–3.78)	**
Multivariable-adjusted[a] odds ratio (95% CI)	1.00 (reference)	0.86 (0.43–1.71)	1.46 (0.79–2.72)	2.12 (1.13–3.98)	*
Body mass index (kg/m^2)	≤20.81	20.82–22.30	23.31–24.05	≥24.06	
n	285	290	289	288	
Men-years of follow-up	6,555	6,670	6,647	6,624	
Persistent LBP per 10,000 men-years	26	33	33	44	
Age-adjusted odds ratio (95% CI)	1.00 (reference)	1.31 (0.68–2.52)	1.37 (0.71–2.65)	1.86 (0.99–3.49)	**
Multivariable-adjusted[a] odds ratio (95% CI)	1.00 (reference)	1.32 (0.68–2.55)	1.37 (0.71–2.68)	1.74 (0.89–3.39)	*

[a]Adjusted for age, drinking, smoking, and maximal oxygen uptake.
*p<0.05, **p<0.01
CI: confidence interval

Table 4. Multivariable-adjusted odds ratios for incidence of persistent low back pain according to body mass index category based on WHO classification

	<18.50	18.50−24.99	25.00−29.99	≥30.00	p for linearity
n	45	924	169	14	
Men-years of follow-up	1,035	21,252	3,887	322	
Persistent LBP per 10,000 men-years	29	32	44	93	
Age-adjusted odds ratio (95% CI)	0.89 (0.27−2.94)	1.00 (reference)	1.47 (0.84−2.57)	3.46 (0.94−12.73)	**
Multivariable-adjusted[a] odds ratio (95% CI)	0.91 (0.27−3.03)	1.00 (reference)	1.37 (0.75−2.49)	3.31 (0.86−12.70)	*

[a]Adjusted for age, drinking, smoking, and maximal oxygen uptake.
*p<0.05, **p<0.01
CI: confidence interval

taking into account the factors considered to be potential confounding factors, affecting the relationship between persistent low back pain prevalence and obesity. No clear relationship between age, maximal oxygen uptake, alcohol intake, smoking habits, and persistent low back pain was observed with respect to any of these factors.

Table 3 shows the age-adjusted and multivariable-adjusted odds ratios for %FAT and BMI and persistent low back pain prevalence by quartile. A significant positive dose-response relationship was shown between %FAT and persistent low back pain prevalence (p for linearity=0.010). Similarly, a significant positive dose-response relationship was confirmed between BMI and persistent low back pain (p for linearity=0.018). Using the group with the lowest %FAT as a reference, the multivariable-adjusted odds ratio (95% confidence interval) for the group with the highest %FAT with persistent low back pain was 2.12 (1.13–3.98). In contrast, this ratio was 1.74 (0.89–3.39) for BMI, and %FAT exhibiting a higher odds ratio.

To facilitate comparison of our results with those of previous studies, four BMI groups, thin (>18.50), average (18.51–24.99), overweight (25.00–29.99), and obesity (≥30.00), were designated according to WHO obesity classification. The odds ratios for persistent low back pain prevalence for these four groups are displayed in Table 4. This study targeted Asian populations, who comprise a small portion of the number of obese people worldwide. In addition, only 14 (1.2%) people classified as obese according to WHO criteria participated in the study, and participants included only 169 (14.7%) people classified as overweight. In contrast, the multivariable-adjusted odds ratio for persistent low back pain prevalence was 1.37 in the overweight group and 3.31 in the obese group, confirming that the risk for persistent low back pain was higher in overweight and obese groups.

DISCUSSION

In this study, the relationship between %FAT and BMI, which are an index of obesity, and persistent low back pain prevalence was evaluated longitudinally based on data collected from male workers in Japan. Our results revealed a positive dose-response relationship between obesity index and persistent low back pain, suggesting that obesity is a risk factor for persistent low back pain prevalence. This result was the same even when adjusting for multiple confounding factors using a logistic regression model.

The results of previous studies of the relationship between obesity and low back pain-related diseases in Japanese people showed similar results based on short-term follow-up[18, 19], but this is the first study to determine the relationship between obesity and low back pain over a long period.

The results of meta-analysis studies of the relationship between obesity and low back pain suggest that there is a positive relationship between obesity and low back pain, similarly to the results of this study[8, 9]. Further, in a large-scale nationwide survey conducted in Norway over an 11 year period[10, 11], a significant positive dose-response relationship between an obesity index (BMI) and chronic low back pain was reported for both males and females. However, studies targeting Western populations include a considerably different distribution of obesity compared to the participants assessed in this study. Male participants in the Norwegian National Large Scale Survey[11] were divided into three groups: average (<25.0), overweight (25.1–29.9), and obesity (≥30.0), and the respective proportion of participants falling into these groups were 33%, 54%, and 13%, respectively, which is markedly different from the 84%, 15%, and 1% distribution observed during this study. In contrast, a positive dose-response relationship was observed between obesity and low back pain in both studies targeting Western populations and our study focusing on Asian populations; accordingly, a relative obesity trend is considered to be a risk factor for low back pain prevalence rather than the absolute obesity index.

Two plausible mechanisms may explain the relationship between obesity and persistent low back pain observed in this study: 1) biomechanical viewpoint and 2) association with endogenous substances.

The biomechanical viewpoint considers factors such as burden on the spinal column (intervertebral disc) when obesity increases abdominal size. Fabris de Souza et al.[20] researched postural changes in obese subjects who exhibited a collapsed condition of whole body alignment resulting from increased downward gravity, excessive thoracic posterior curvature, and lumbar anterior curvature with respect to the spinal column. As such, the gain in mass in the upper body because of obesity increases the load on the vertebral discs, even when in standing or sitting positions. In addition, because gravitational pressure is further increased when an obese person bends the upper body forward, a greater force on the back muscle group becomes necessary, which is the main source of increased disc load.

Next, regarding the association with endogenous substances, it is thought that the proinflammatory cytokines induced by adipokines, which are secreted by adipocytes that proliferate in the obese state, may be associated with pain. Tumor necrosis factor α and interleukin-6 are representative proinflammatory cytokines, and serum interleukin-6 levels are thought to be elevated in obese people[21]. As such, in hypertrophied adipocytes, abnormal secretion of endogenous substances such as adipokines and inflammatory cytokines may disrupt the balance of the endocrine system and be associated with pain.

In this study, BMI, which is one index of obesity calculated as a ratio of weight to height, and %FAT, which is more accurately, but indirectly evaluates the amount of adipocytes in the body, were calculated. We confirmed that %FAT is more strongly correlated with the prevalence of persistent low back pain than BMI. This supports the consideration that the amount of adipocytes is associated with persistent low back pain. Therefore, based on our results and those of previous studies as well as the mechanisms explained above, maintaining one's current weight regardless of the obesity standard and avoiding increases in body weight (increases in fat mass) are thought to be important for preventing persistent low back pain in both the near and far future. Our results suggest that obesity education and exercise guidance to avoiding increasing weight need to be importantly considered for prevention and treatment of low back pain.

The present study has some limitations. First, the study only included males in a metropolitan area. Second, it did not survey psychosocial or ergonomic factors associated with low back pain. Therefore, these parameters could not be adjusted for as confounders in the analysis. However, this is the first long-term cohort study designed to investigate the relationship between obesity and low back pain in Japanese workers. Moreover, by investigating the relationship with persistent low back pain using %FAT as well as BMI as an index of obesity even in a population with a relatively low prevalence of obesity, we demonstrated that accumulation of body fat is a risk factor for low back pain. These results will contribute to studies of methods aimed at preventing persistent low back pain. Further studies should include additional populations including females as study participants in order to broaden the applicability of the sample population and produce results that more accurately reflect the prevalence of persistent low back pain.

In conclusion, a significant positive dose-response relationship was observed between obesity index and persistent low back pain prevalence in Japanese males, and a relatively high %FAT and BMI were found to be risk factors for persistent low back pain. The results of this study suggest that weight control is important for preventing future persistent low back pain.

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Improvement of walking ability during postoperative rehabilitation with the hybrid assistive limb after total knee arthroplasty: A randomized controlled study

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Abstract

Objective: We aimed to compare the efficacies of rehabilitation with the hybrid assistive limb and conventional rehabilitation after total knee arthroplasty.

Materials and methods: A total of 37 consecutive patients who underwent primary total knee arthroplasty for knee osteoarthritis were enrolled. Seven patients withdrew from the study after randomization, and 30 patients (hybrid assistive limb group: n = 16; conventional group: n = 14) completed the randomized controlled trial. Patients in the hybrid assistive limb group underwent ten 20-min rehabilitation sessions with the hybrid assistive limb as well as 20-min conventional sessions over the course of 2 weeks, whereas patients in the conventional group received ten 40-min conventional sessions during the same period. The primary outcome measure was walking speed, whereas the secondary outcome measures included quadriceps strength and knee pain assessed using a numerical rating scale. The outcome measures were evaluated prior to surgery and on postoperative weeks 1, 2, and 3.

Results: In the early postoperative period, rehabilitation after total knee arthroplasty with the hybrid assistive limb resulted in a significantly greater improvement in walking speed (weeks 1 and 2: $p = 0.045$), quadriceps strength (weeks 1 and 2; weeks 1 and 3: $p < 0.0001$), and numerical rating scale scores (week 1: $p = 0.03$) than conventional rehabilitation.

Conclusion: Rehabilitation with the hybrid assistive limb after total knee arthroplasty led to greater improvements in walking speed, quadriceps strength, and pain scores than conventional rehabilitation.

Keywords

Hybrid assistive limb, total knee arthroplasty, randomized controlled trial, osteoarthritis, rehabilitation

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Introduction

Total knee arthroplasty (TKA) is the most widely used surgical treatment for end-stage osteoarthritis (OA) of the knee and is reportedly effective in alleviating pain, enabling functional recovery, and improving the quality of life (QOL).[1,2] It is also considered to be a safe surgical procedure.[3]

In Japan, the mean duration of hospitalization for TKA is 35.1 ± 15.9 days, whereas that for initial TKA only is 35.0 days.[4] It is important to minimize the hospitalization period as this reduces associated healthcare costs. Since the time of discharge usually depends on walking ability, patients who start walking sooner can be discharged more quickly.

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The hybrid assistive limb (HAL) is an exoskeletal robot suit developed in 1992 to provide the wearer with physical support during daily activities and heavy labor.[5] The HAL for the lower limbs was developed as a gait assistance system for individuals with difficulty in standing up, sitting down, and climbing stairs.[6] The HAL has two modes: a voluntary control mode and an automatic control mode. In the voluntary control mode, the suit provides support for physical activities based on weak bioelectric signals generated when the wearer makes a voluntary movement.[7] These bioelectric potentials are detected by electrodes attached to the surface of the skin. In most cases, the electrodes are attached to the quadriceps femoris and gluteus maximus muscles in the area around the hip joint and the vastus lateralis and biceps femoris in the area around the knee. The assistive force generated by the HAL power unit is calculated based on the bioelectric potentials generated by the muscles. This approach is used to support and control movements.[8] In the voluntary control mode, the HAL provides functional support for multiple joints of both legs simultaneously, which makes it suitable for use by individuals with leg disabilities as well as healthy individuals.[9] Accordingly, HAL training, which utilizes the wearer's own muscle activity, could enhance the feedback for inducing appropriate movements better than standard robotic training.[10]

One study (a randomized controlled trial) assessed the use of the HAL in rehabilitation for improving locomotion in the recovery phase after cerebral stroke,[10] and several reports have documented its use in rehabilitation of patients with cerebral stroke and spinal cord injury to promote gait improvements.[11] However, to our knowledge, there have been few reports on the use of HAL in rehabilitation after TKA only, both in terms of pilot studies[12] and case reports.[13]

We hypothesized that, in addition to the effects demonstrated in previous studies, the HAL may also be useful for facilitating the recovery of leg function and gait function in patients after TKA. To test this hypothesis, we decided to assess the rate of change in walking speed rather than walking speed alone since the latter varies widely depending on the baseline values. In the present randomized controlled trial, we aimed to verify whether the HAL can be used in rehabilitation after TKA to promote functional recovery.

Materials and methods

Participants

All patients underwent primary TKA for knee OA at JR Tokyo General Hospital between September 2014 and August 2015. Patients were enrolled according to the following inclusion criteria: scheduled to undergo primary TKA due to OA and age of 65–80 years. The exclusion criteria were as follows: inability to receive concurrent physical therapy; presence of rheumatoid arthritis, stroke, malignant tumor, Parkinson's disease, dementia, active infection, pulmonary embolism, or deep vein thrombosis; body dimensions inappropriate for the use of the HAL; presence of skin disease precluding electrode placement; and presence of an implanted pacemaker.

Randomization

Patients meeting the inclusion criteria were randomly assigned in a 1:1 ratio to the HAL group or to the conventional training group. Randomization was performed according to age and sex. To ensure that all doctors, institutional investigators, assessors, and patients involved in the trial remained blinded to treatment assignment, the randomization was performed by an independent organization, the 22nd Century Medical & Research Center of the University of Tokyo.

Study protocol

We used a computer-generated sequence, with odd-numbered patients participating in rehabilitation using the HAL and even-numbered patients participating in conventional training. Patients in the HAL group performed gait rehabilitation with the HAL five times a week for a total of 10 HAL training sessions (over the course of 2 weeks). Patients in the conventional group performed conventional gait rehabilitation five times a week for a total of 10 conventional training sessions (over the course of 2 weeks). Patient demographics and baseline values of outcome measures were assessed prior to randomization into treatment groups. The study was approved by the Ethics Committee of the JR Tokyo General Hospital. All patients provided written informed consent prior to participation.

Rehabilitation using the HAL

The HAL for the lower limbs was used in all the patients (Figure 1). One 40-min session was completed once a day. While wearing the HAL, patients performed quadriceps muscle strength exercises in a sitting position and practiced standing up from a seated position for 20 min. They also undertook a single 20-min rehabilitation session consisting of range of motion exercises and walking. HAL instructors were skilled and experienced physical therapists licensed to use the HAL. The cybernic voluntary control mode was used.

Conventional rehabilitation

Conventional training was performed for 40 min once a day. Patients performed the same 20-min program of quadriceps muscle strength exercises and standing up from a seated position as in the HAL group but without wearing the HAL. They also completed a single 20-min rehabilitation session of range of motion exercises and walking. Conventional training instructors were skilled and experienced physical therapists.

Assessment

All measurements were conducted by physical therapists trained to perform standardized assessment procedures. The outcome measures were evaluated prior to surgery and on postoperative weeks 1, 2, and 3. The primary outcome measure was walking speed. For the assessment of walking speed, patients walked 10 m on the ground at a comfortable speed. The secondary outcome measures included quadriceps strength and knee pain assessed using a numerical rating scale (NRS). Isometric contraction quadriceps strength of knee extension was measured used a hand-held dynamometer (μtas F-1). A pressure sensor was fixed to the belt worn around the ankle to record the maximum power. The maximum value from three trials was used in the analysis.

Statistical analysis

To ensure balanced randomization, we tested the differences between the HAL and conventional groups at baseline using the Fisher exact test for sex and unpaired t-tests for age, height, weight, body mass index (BMI), walking speed, and quadriceps strength. The primary outcome was the difference in the change of walking speed between the two groups between week 1 and week 2 or 3, which was assessed by a paired t-test. The change ratio was calculated using the following formula: ([follow-up] − [week 1])/[week 1]) × 100. All statistical tests were performed at a significance level of 0.05 (two-sided) without adjusting for multiple testing.

The sample size was calculated in a preliminary study to detect a difference between the groups in change ratio of walking speed of 10%. A sample size of 15 patients per group (30 patients in total) resulted in a power of 80%.

Data analyses were performed using SAS, version 9.1.3 (SAS Institute Inc., Cary, NC).

Results

Figure 2 shows the flow chart of patient enrollment and participation. A total of 37 patients underwent primary TKA and were assessed for eligibility. Among the 16 subjects allocated to the HAL group, 1 withdrew consent, 1 could not continue

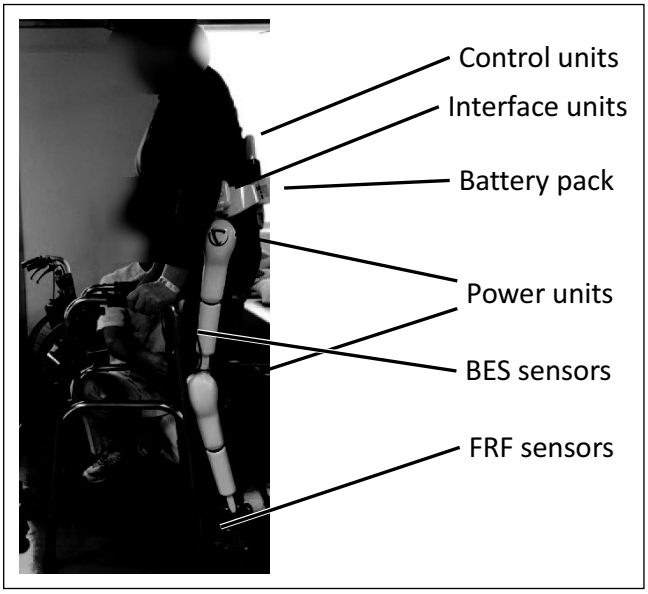

Figure 1. Training in standing up from a seated position with the HAL.
BES: bioelectrical signal; FRF: floor reaction force.

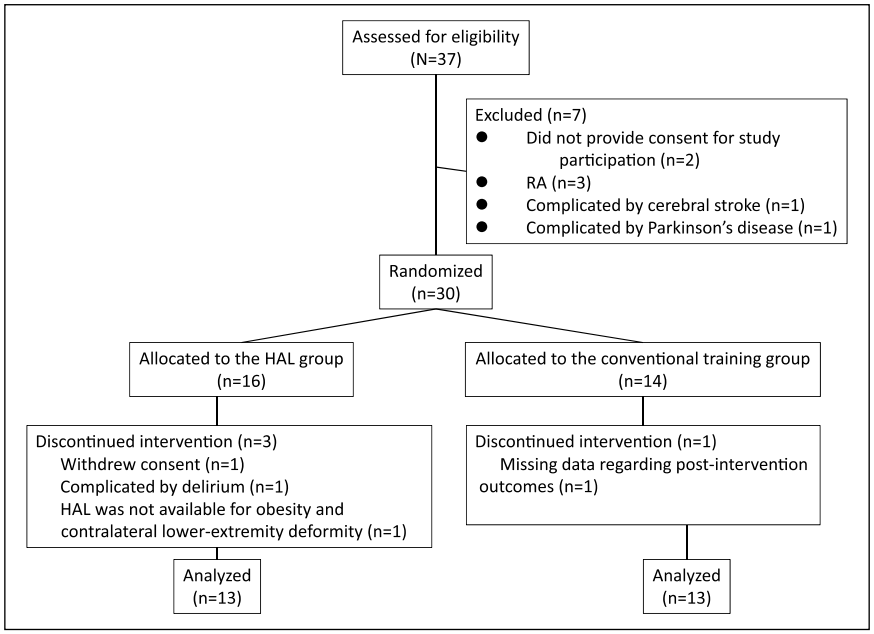

Figure 2. Flow chart of patient enrollment and participation.
RA: rheumatoid arthritis.

Table 1. Demographics and preoperative descriptive parameters in the HAL and conventional groups.

	HAL group	Conventional group	p value
Sex (male/female)	3/10	3/10	1.00
Age (years)	75.5 ± 5.4	75.6 ± 4.5	0.97
Height (cm)	151.5 ± 8.1	153.7 ± 6.6	0.45
Weight (kg)	59.4 ± 10.9	59.6 ± 9.2	0.95
Body mass index	25.7 ± 3.1	25.2 ± 3.0	0.66
Walking speed (preoperative)	0.94 ± 0.33	0.92 ± 0.28	0.85
Quadriceps strength (preoperative)	0.82 ± 0.34	0.93 ± 0.42	0.48

HAL: hybrid assistive limb.
Values are presented as number or mean ± standard deviation, unless otherwise indicated.

Table 2. Rates of change in walking speed and quadriceps strength in the two groups.

		HAL group	Conventional group	p value
Walking speed (%)	Week 1–week 2	9.5 ± 11.2	0 ± 10.0	0.045
	Week 1–week 3	20.0 ± 22.3	16.2 ± 16.3	0.66
Quadriceps strength (%)	Week 1–week 2	172.4 ± 288.4	62.2 ± 85.7	<0.0001
	Week 1–week 3	249.2 ± 362.6	94.3 ± 115.0	<0.0001

HAL: hybrid assistive limb.
Values are presented as number or mean ± standard deviation, unless otherwise indicated.

rehabilitation because of delirium, and 1 could not use the HAL because of obesity and contralateral lower-extremity deformity. Among the 14 subjects allocated to the conventional training group, post-intervention outcomes could not be assessed for 1 subject. Thus, a total of 26 subjects completed the study. No differences were observed in the demographics and baseline clinical data between the two groups (Table 1).

A comparison of the rates of change in walking speed between week 1 and week 2 after TKA revealed significantly better values for patients who underwent rehabilitation with the HAL. In contrast, a comparison of the rates of change in walking speed between week 1 and week 3 after TKA did not show a significant difference (Table 2).

A comparison of the rates of change in quadriceps strength between postoperative weeks 1 and 2, as well as postoperative week 1 and 3, showed significant differences between the two groups (Table 2). Moreover, a significantly greater number of patients who did not use the HAL had a high pain score (≥6) at 1 week postoperatively. However, there was no difference in the NRS scores between the two groups at 2 weeks or 3 weeks postoperatively, and the scores improved over time in both groups (Table 3).

Table 3. Numbers of participants with high NRS scores (≥6).

	HAL group	Conventional group	p value
Postoperative week 1	1	6	0.03
Postoperative week 2	2	5	0.38
Postoperative week 3	0	1	0.48

HAL: hybrid assistive limb; NRS: numerical rating scale.

Discussion

To our knowledge, this is the first randomized controlled trial of the use of the HAL for rehabilitation after TKA. We found that, compared to conventional rehabilitation, the use of the HAL during early rehabilitation after TKA efficiently improved locomotion and quadriceps femoris strength, while reducing pain.

In this study, walking speed was used as a measure of postoperative recovery. Walking speed has a low failure rate (<5%) in the elderly[14] and is a highly reliable indicator, with an intra-session correlation coefficient of 0.90–0.98 and an inter-session correlation coefficient of 0.78–0.94 among patients with knee OA.[15] Changes in comfortable walking speed reflect the ability to respond to conditions that occur during environmental changes and when crossing intersections and avoiding obstacles.[16] Moreover, walking speed has been found to be correlated with other indicators such as the Berg Balance Scale score[17] and timed up and go (TUG) test results,[18] both of which reflect the balance function. In a study by Cress et al.[19] conducted in 200 elderly residents of a nursing home, walking speed was an independent factor reflecting physical function.

The change in walking speed after TKA is also considered an indicator of the effectiveness of rehabilitation.[20] A study of post-discharge walking speed in 57 patients with knee OA who underwent initial TKA found that the mean post-discharge 10-m walking speed was 0.7 ± 0.2 m/s.[21] In general, the walking speed[21] and TUG test results[22] decrease temporarily

after discharge following TKA, followed by recovery over several months and improvement beyond the preoperative levels.

In this study, the rate of change in walking speed between weeks 1 and 2 after TKA was significantly better in patients who underwent rehabilitation with the HAL. However, there was no significant difference between the two groups in the rate of change in walking speed between postoperative weeks 1 and 3. These results suggest that the use of the HAL in rehabilitation after TKA is particularly valuable during the early part of the postoperative recovery phase, with the difference between HAL and conventional rehabilitation diminishing over time.

It was found that 44.4% of patients experience persistent severe pain 1 month after TKA.[23] Pain affects functional recovery after TKA as it restricts walking and reduces walking speed. We used the NRS as a pain measure. A significantly greater number of patients who did not use the HAL had a high pain NRS score (≥6) at 1 week postoperatively. However, there was no difference in the NRS scores between the two groups at 2 weeks and 3 weeks postoperatively, and the scores exhibited improvement over time in both groups. This suggests that the use of the HAL during the early postoperative period reduced pain during rehabilitation. This might have a beneficial effect on the recovery of walking speed.

The mechanism through which the use of the HAL improves gait function after TKA remains unclear. Quadriceps arthrogenic muscle inhibition (QAMI) may be one reason for the effectiveness of rehabilitation after TKA. QAMI is the phenomenon of inhibition of the quadriceps femoris muscle after surgery.[24] It is believed to result from pain or swelling of the knee or damage to pressure receptors[24] and may also occur because of swelling of the knee alone.[25] At present, the suggested mechanisms for QAMI include possible inhibition of α motor neurons via the spinal reflex[26] and involvement of pathways engaging upper motor neurons.[24]

Concentrated repetition of specific tasks is also known to induce neural plasticity and promote functional recovery from paralysis following stroke or spinal cord damage.[27–31] In this study, the rates of change in quadriceps strength between postoperative weeks 1 and 2 and between postoperative weeks 1 and 3 were significantly different between the two groups. These results suggest that the knee could be affected by the QAMI phenomenon after TKA, and the effectiveness of repeating specific tasks in combination with the feedback provided by the use of the HAL might promote neural plasticity, thus improving quadriceps function and enabling the recovery of gait function during the early recovery phase.

Limitations

This study has certain limitations. First, fitting the HAL requires considerable time and effort, and adjustments are needed in the sites of attachment of the electrodes and settings such as the assistance level. Therefore, the level of familiarity of the physiotherapists with the HAL may have affected the results.

The second limitation concerns the device itself. The HAL used in this study was designed as an assistive device for both legs. To adapt the system for functional recovery after TKA, a model wore the HAL on only one leg, which reduced the weight of the device and allowed freedom of movement of the unaffected leg, thus increasing its efficiency.

The third limitation originates from the unique medical insurance system, in which medical procedures from surgery to discharge are fully covered. This study showed only that using the HAL facilitated functional recovery of patients after TKA. There is a possibility that early functional recovery after TKA promoted by the use of the HAL reduced the hospitalization time. The latter effect would be limited to Japan, where hospital stay is longer than in Western countries.

Furthermore, it was reported by Husted that fast-track knee arthroplasty has low morbidity and mortality, as well as high patient satisfaction.[32] Considering the short hospitalization period for fast-track knee arthroplasty in Western countries, using the HAL will not shorten the length of hospital stay. In Japan, the discharge conditions are much stricter than those in Western countries (i.e. more than 1 m/s on 10-min walk test, visual analog scale <3). Thus, using the HAL can be feasible in Japanese patients given the longer hospital stay.

Clinical messages

- This is the first randomized controlled trial of the use of the HAL for rehabilitation after TKA.
- The use of the HAL during early rehabilitation after TKA efficiently improved locomotion and reduced pain compared to conventional rehabilitation.
- It is necessary to improve the device by adapting it for use after TKA.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

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Informed consent

All patients provided written informed consent prior to participation.

Trial registration information

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SHORT COMMUNICATION

Psychosocial correlates of cortisol levels in fingernails among middle-aged workers

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ABSTRACT

It was recently suggested that cortisol levels in fingernails reflect cumulative hormone exposure over a relatively long period. This exploratory study cross-sectionally investigated the relationships between fingernail cortisol level and psychosocial stress in a sample of middle-aged workers (94 men and 29 women). The participants were asked to grow their fingernails for ~2 weeks and then provide fingernail samples from every digit by using nail clippers. Further, they completed questionnaires for assessment of exposure to psychosocial stress in the past (stressful life events in the workplace in the previous year; e.g. change to a different line of work) and in the present (job stress and perceived stress). Results of a regression analysis adjusting for the effects of demographic variables showed that experience of stressful life events, but not job stress and perceived stress, was associated with elevated fingernail cortisol level. These findings indicate the potential of fingernail samples to retrospectively reflect individual differences in cortisol levels related to past psychosocial stress.

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Cortisol; fingernail; job stress; stressful life events; hair cortisol; perceived stress

Introduction

Psychosocial stress triggers a number of physiological changes such as activation of the sympathetic nervous system and hypothalamic–pituitary–adrenal (HPA) axis. One consequence of this activation is the release of cortisol, an adrenal cortex hormone secreted in response to acute stress (Dickerson & Kemeny, 2004). Traditionally, cortisol has been measured in blood and saliva samples. The analysis of saliva and blood hormone level provides an index for a short period. Several recent studies have shown that endogenous hormones such as cortisol can reliably be measured in scalp hair (Russell, Koren, Rieder, & Van Uum, 2012). Scalp hair grows at an average rate of 1.0 cm/month; therefore, 1.0 cm of scalp hair may reflect hormone levels secreted in 1 month. While analysis of saliva and blood hormone levels provides an index for a short period, hair sample analysis provides a retrospective index of cumulative hormone exposure over a longer period, which could have advantages in the investigation of cortisol levels and chronic stress.

It was recently suggested that cortisol levels in fingernails also reflect cumulative hormone exposure over a relatively long period (de Berker, André, & Baran, 2007; Warnock et al., 2010). Neutrally charged endogenous hormones passively diffuse from capillaries into the nail matrix, and are incorporated into keratin during nail formation (de Berker et al., 2007). In this process, free cortisol may be incorporated into keratin through the same mechanism by which cortisol is incorporated into hair (Russell et al., 2012). Fingernails grow at an average rate of 1.0 mm/10 days (Gupta et al., 2005); therefore, 1.0 mm of fingernail may retrospectively reflect hormone levels over 10 days. In addition, previous work that traced fluoride in nails found that 3–4 months were required for nails to fully extend from the nail matrix (Buzalaf, Pessan, & Alves, 2006). Therefore, fingernail samples may reflect cortisol levels in the 3–4 months prior to clipping. In a recent study (Izawa et al., 2015), it was reported that cortisol levels in fingernails were associated with cortisol levels in the past that were assessed by hair and saliva samples. However, no previous studies clearly demonstrated the relationship between fingernail cortisol and psychosocial stress as well demographic variables, and minimal information is available on the fundamental aspects of fingernail cortisol.

This exploratory study cross-sectionally investigated the relationships between fingernail cortisol level and psychosocial stress in the past (stressful life events in the workplace in the previous year) and in the present (job stress and perceived stress) in a sample of middle-aged workers. This population was chosen because psychosocial stress in the workplace is associated with stress-related disease and could cause numerous biological changes (e.g. Eller et al., 2009). We expected that fingernail cortisol level would be positively associated with psychosocial stress, especially for stressful life events in the previous year, because fingernail samples reflect cumulative hormonal exposure in the past. Furthermore,

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we additionally investigated the effects of demographic variables (age, gender, body mass index, smoking status, and manicure use) on fingernail cortisol level.

Methods

Participants

White-collar workers were recruited from hospitals and research institutes in Kanagawa Prefecture in Japan. The sample consisted of hospital personnel and research institute staff who were mainly engaged in desk work. The sample initially comprised 140 workers; however, 17 were excluded for various reasons: six for recent steroid injection or medication use, two for antidepressant use, one for history of an adrenal gland tumor, one for recently giving birth to a child, three for missing questionnaire data, and four for containing statistical outliers regarding fingernail cortisol (see results section for additional details). Therefore, the final sample consisted of 123 workers (94 men; 29 women). Of the 123 participants, none reported adrenal gland disease such as Cushing's syndrome or Addison's disease, and none were taking steroid medications or antidepressants. Written informed consent was obtained from participants, and the ethical committees of the National Institute of Occupational Safety and Health approved the study.

Questionnaires

Stressful life events in the workplace were assessed using the following six items derived from the Social Readjustment Rating Scale (Holmes & Rahe, 1967): "collapse of the company", "disemployment", "job change", "change in job responsibility", "change to different line of work", and "merger and reorganization". Participants were asked whether they had experienced any of these six life events during the previous year using a yes/no format.

Job stress was assessed on a six-item measure derived from the Brief Job Stress Questionnaire (Shimomitsu, Yokoyama, Ono, Maruta, & Tanigawa, 1998), which was based on the job stress model of Karasek and Theorell (1990). Three items pertained to job demands (e.g. "have an extremely large amount of work to do") and three items concerned perceived job control (e.g. "can choose how and in what order to do work"). Each item was rated on a four-point Likert scale ranging from "disagree" to "agree", and the Cronbach's alpha coefficient of job demands and control items was .77 and .75, respectively. The job strain index was calculated by dividing job demands by job control. A job strain of six items indicated a balance between demands and control, with higher scores reflecting high demand coupled with low control.

Perceived stress was assessed using the Japanese version of the Perceived Stress Scale (Iwahashi, Tanaka, Fukudo, & Hongo, 2002; PSS). The PSS is a 14-item questionnaire with five response options that assess the perceived degree of stressfulness of situations over the past month (e.g. "how often have you felt that things were going your way?"). The internal reliability (alpha coefficients) range from .82 to .89.

Procedure

For collection of fingernail samples, participants were asked to grow their fingernails for $\sim$2 weeks and provide samples from every digit by using nail clippers with a catcher to minimize tissue loss. Participants with manicured hands were asked to remove any nail polish before clipping. Fingernail samples were transferred into a Ziploc bag and frozen at $-30\,^{\circ}$C prior to the assay.

Participants also completed a questionnaire that assessed smoking status, height, weight, and frequency of nail polish use at the time of sample collection. Collection of fingernail samples and the questionnaire survey were conducted once in January 2012 or in February 2012.

Nail hormone extraction and enzyme immunoassay

Our nail hormone extraction method was identical to that used in a previous study (Izawa et al., 2015). Each sample was transferred into a 15-mL Falcon tube. Then, 5 mL of isopropanol was added, and the tube was vortexed twice for 60 s. This washing procedure was repeated two times. Samples were air-dried overnight. Dried samples were transferred to a 2.0-mL polypropylene micro-tube with a zirconia ball (diameter, 5 mm) and ground for 40 min using a mixer mill (Retsch MM300, Haan, Germany) set at 30 Hz. Fifteen milligrams of fingernail powder was transferred to another 2.0-mL micro-tube, followed by the addition of 1.5 mL of pure methanol. The micro-tube was slowly rotated for 24 h at room temperature to allow for steroid extraction. Following this, the micro-tube was centrifuged at 10,000 rpm for 2 min. One milliliter of the clear supernatant was transferred into a 50-mL Falcon tube, and subjected to evaporation for $\sim$20 min at 60 °C until completely dry.

Cortisol level was determined by an enzyme immunoassay method using the EIA Kit (Salimetrics LLC, State College, PA). The evaporated samples were re-suspended in 100 µl of the assay diluent included in the EIA Kit, and the levels of cortisol in the diluent were analyzed according to the manufacturer's instructions. The inter-assay and intra-assay variations were $<$6.41 and 3.65%, respectively. The findings are presented as pg cortisol/mg fingernail (pg/mg). The lowest detectable level of cortisol is 0.56 pg/mg. We previously confirmed that the dilution curve of cortisol levels measured in serially diluted fingernail extracts significantly paralleled the cortisol standard curve from the assay kit (Izawa et al., 2015).

Statistical analyses

Cortisol levels in fingernails were logarithmically transformed (base 10) because their distribution in this sample was skewed. Further, the Smirnov–Grubbs tests for transformed values were performed to find statistical outliers. Correlational analyzes, independent *t*-tests, and a multiple linear regression analysis were subsequently conducted to evaluate the effect of stressful life events in the workplace, job strain, and perceived stress on cortisol level in fingernails. Age, gender (male/female), body mass index (BMI), and smoking status (yes/no) were included in the regression analysis.

Table 1. Demographics of the participants.

Demographic variable	*N* or mean ± SD
Male/female	94/29
Age (years), mean ± SD	43.4 ± 10.2
BMI (kg/m^2), mean ± SD	23.2 ± 3.5
Smoking status (no/yes)	91/32
Stressful life events in the workplace (0/1+)	75/48
Job strain (demand/control), mean ± SD	1.1 ± 0.5
Perceived stress, mean ± SD	22.5 ± 6.4
Cortisol level in fingernails (pg/mg), mean ± SD	4.6 ± 2.4

Table 2. Results of the multiple regression analysis for cortisol level in fingernails.

Independent variables	b (SE)		β	*p*
Gender (male/female)	−0.050	(0.044)	−.104	.263
Age	0.001	(0.002)	.051	.581
BMI	−0.002	(0.005)	−.039	.664
Smoking status (no/yes)	0.114	(0.041)	.248	.006
Stressful life events in the workplace (0/1+)	0.087	(0.036)	.209	.019
Job strain	0.056	(0.036)	.152	.125
Perceived stress	−0.003	(0.003)	−.082	.406

The distribution of the number of experienced stressful life events was skewed; we coded this variable as "0" (did not experience any stressful events) and "1" (experienced one or more stressful events).

Furthermore, the effect of nail polish could be evaluated in 19 women, and nail hormone levels were compared between women who used nail polish ($N = 11$) and those who did not ($N = 8$) using an independent *t*-test. All statistical calculations were performed using PASW Statistics 18 for Windows (SPSS Inc., Tokyo, Japan).

Results

The Smirnov–Grubbs test identified four statistical outliers ranging from 46.0 to 142.4 pg/mg, which were excluded from analyzes. The means and standard deviation (SD) of fingernail cortisol, as well as demographic and psychosocial variables, are presented in Table 1. Participants who experienced one or more stressful life events (i.e. the 1+ group) experienced an average of 1.4 (±0.5) stressful life events. Fingernail cortisol levels between women who used nail polish (mean ± SD: 4.3 ± 4.1 pg/mg) and those who did not (3.4 ± 1.0 pg/mg) were not significantly different.

The means and SD of fingernail cortisol in the participants without and with stressful life events in the workplace were 4.2 ± 2.1 and 5.2 ± 2.7 pg/mg, respectively. Cortisol levels significantly differed between the groups [$t(121) = 2.62$, $p = .010$]. Job strain and perceived stress did not correlate significantly with fingernail cortisol levels. The results of a multiple linear regression analysis are also shown in Table 2. Smoking status and experience of stressful life events in the workplace were significantly associated with higher fingernail cortisol levels.

We found a moderate correlation between job stress and perceived stress ($r = .45$, $p < .01$), implying a possibility of collinearity in the regression analysis. However, excluding job stress or perceived stress from the regression analysis did not alter the results.

Discussion

This exploratory study investigated the relationship between fingernail cortisol level and psychosocial stress (stressful life events, job stress, and perceived stress) in a sample of middle-aged workers. We found that stressful life events in the workplace, but not job strain and perceived stress, were associated with higher cortisol levels in fingernails after adjusting for the effects of demographic factors. Fingernail samples reflect cumulative hormonal exposure in the past. Therefore, it could be interpreted that fingernail cortisol is associated with psychosocial stress in the past (stressful life events in the previous year), rather than in the present (job stress and perceived stress). Life events in the workplace such as changing to a different line of work are generally recognized as stressful (Holmes & Rahe, 1967). A recent retrospective study (Grassi-Oliveira et al., 2012) found a positive association between hair cortisol levels and number of negative life events, consistent with the findings of this study. To the best of our knowledge, this is the first study to demonstrate a relationship between fingernail cortisol level and psychosocial stress.

In this study, we also investigated the effects of demographic variables on fingernail cortisol, and found that smokers had higher fingernail cortisol levels. This result was consistent with previous findings on salivary cortisol, in which smokers exhibited higher cortisol levels (e.g. Steptoe & Ussher, 2006). However, we did not find significant associations between fingernail cortisol and other demographic variables (age, gender, BMI, and manicure use). BMI has been frequently reported to be associated with hair cortisol (Stalder et al., 2012). However, the lower mean BMI and comparatively limited BMI range of this study could have affected its results.

Fingernail samples could have some advantages, compared with use of saliva and hair samples. Salivary cortisol is known to have large diurnal rhythms and reflect acute increases in hormones, which would confound an investigation of the relationship between cortisol and chronic stress. In contrast, fingernail cortisol level would not be affected by such transient increases and diurnal rhythms. Furthermore, many strands are needed for the measurement of hair cortisol, and hair self-sampling may be difficult for some participants. In contrast, fingernail samples can be self-collected, and only small amounts are required.

This study has certain limitations, which warrant careful interpretation of its findings. First, in this study, we only investigated fingernail cortisol, but not salivary or hair cortisol. More information on relationships between fingernail and salivary or hair cortisol is a key component to advancing the study of fingernail cortisol. Second, we did not account for individual differences in nail growth rate, which could affect observed steroid concentrations. Further, in this restricted study design, participants clipped their fingernails at home (i.e. not in accurately controlled conditions). Third, we did not assess the effects of stressful life events outside the workplace or those of positive life events. While we did ask

participants whether they experienced stressful life events outside the workplace (e.g. death of spouse, divorce, marital separation), the experience rate of most events was quite low, which made it difficult to correlate these events with hormone levels. Fourth, for the assessment of job stress, we did not clearly define the time period of job stress that participants should consider. However, reported job stress may largely reflect participants' experience of stress in the present, but not in the past, because job stress is relatively unstable and variable across time (Kawada & Otsuka, 2014). Fifth, the sample size in this study was small, particularly that of the nail polish use analysis. Therefore, associations of psychosocial stress with fingernail cortisol could not be investigated separately for male and female participants. Furthermore, this study was conducted in healthy middle-aged workers, so not all age groups were represented in our sample.

In conclusion, we demonstrated that experience of stressful life events in the workplace in the previous year was associated with elevated fingernail cortisol level in a sample of middle-aged workers. Thus, we provided evidence that fingernail samples may retrospectively reflect individual differences in cortisol levels related to past psychosocial stress.

Disclosure statement

The authors report no conflicts of interest.

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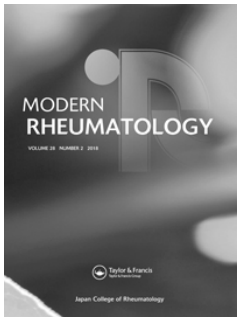

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Assessing joint destruction in the knees of patients with rheumatoid arthritis by using a semi-automated software for magnetic resonance imaging: therapeutic effect of methotrexate plus etanercept compared with methotrexate monotherapy

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ORIGINAL ARTICLE

Assessing joint destruction in the knees of patients with rheumatoid arthritis by using a semi-automated software for magnetic resonance imaging: therapeutic effect of methotrexate plus etanercept compared with methotrexate monotherapy

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ABSTRACT

Objectives: To evaluate the prevention of knee joint destruction and clinical efficacy of methotrexate (MTX) plus etanercept (ETN) compared with MTX monotherapy in patients with rheumatoid arthritis (RA) by using semi-automated software for magnetic resonance imaging (MRI) scan analysis.

Materials and methods: This study enrolled patients with active moderate-to-severe RA who displayed an inadequate response to oral MTX at screening. Patients were assigned to receive either MTX plus ETN or MTX monotherapy (≥10 mg/week). The primary endpoint was the quantitative knee cartilage volume using our software developed for MRI scan analysis.

Results: A total of 18 female patients were enrolled in this study and allocated to the MTX + ETN group ($n = 9$) or the MTX monotherapy group ($n = 9$). At 52 weeks, the quantitative knee cartilage volume was significantly reduced compared with baseline in both groups (MTX plus ETN group: $2.3 \pm 2.3\ cm^3$; MTX monotherapy group: $2.4 \pm 1.6\ cm^3$); however, the difference was not significant.

Conclusion: The semi-automated software for MRI scan analysis can reveal useful and potentially clinically important information about the characteristics of knee joint destruction in patients with RA.

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Cartilage; etanercept; magnetic resonance imaging; methotrexate; rheumatoid arthritis

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease characterized by persistent synovitis that leads to destruction of the bone and cartilage in multiple joints [1]. Thus, estimation of the severity of cartilage destruction and synovial inflammation is important in patients with RA. The evaluation of the cartilage and synovial membrane is generally based on physical examination of the joints and indirect laboratory parameter measurements [2,3]. Recently, magnetic resonance imaging (MRI) has been increasingly used for the assessment of patients with RA, because it allows the assessment of not only cartilage destruction but also synovitis, which is difficult to detect on plain radiographic images [4–6]. In fact, the synovial membrane volume on gadolinium diethylenetriaminepenta-acetic acid (Gd-DTPA)-enhanced MRI has been shown to be highly correlated with local clinical signs of inflammation [7,8]; therefore, the synovial membrane volume may be useful as a marker of disease progression in RA. The Outcome Measures in Rheumatology (OMERACT) Rheumatoid Arthritis MRI Scoring (RAMRIS) method was developed for quantifying synovitis, bone marrow edema, and erosions on the wrist and metacarpophalangeal joints [9]; however, it does not include the assessment of cartilage destruction. In other words, systematic studies in which both the cartilage and the synovium were assessed quantitatively on MRI have not been performed.

Biological agents have been developed for the treatment of RA; they can significantly prevent structural damage. The efficacy of etanercept (ETN) has been demonstrated in clinical trials in patients with RA [10–12], and combination therapy with ETN and methotrexate (MTX) can inhibit the progression of joint destruction in the hands, wrists, and feet, as observed on radiographs [13–14]. However, conventional radiography does not allow detailed evaluation of structural outcomes, as it only shows the late destructive consequences of preceding synovitis. Furthermore, a previous study based on epidemiological data showed that joint destruction, including contractures, fixed flexion, and valgus deformities, was particularly evident in knee joints [15]. Unfortunately, there is no clear evidence regarding the progression of knee joint destruction, as assessed by MRI, in a

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clinical trial of patients with RA. Therefore, precise evaluation of the synovium and cartilage is necessary for understanding the outcomes of therapy in patients with knee RA. Hence, we developed a semi-automated software to quantify the synovial membrane and cartilage volumes on high-resolution knee MRI. We hypothesized that inflammatory synovitis leads to cartilage destruction, and therefore, the inflammatory synovial membrane volume at the start of treatment can be used to predict articular cartilage volume reduction.

The aim of the present study was to conduct a clinical trial comparing MTX + ETN and MTX monotherapy to investigate the association between MRI-determined synovial membrane and cartilage volumes in patients with knee RA.

Materials and methods

Sources of data

This study enrolled patients aged 20–80 years (at time of consent) with active moderate-to-severe RA, based on the 1987 ACR criteria [16] and 28-joint Disease Activity Score (DAS-28) $\geq$ 3.2 [17], who displayed inadequate response to oral MTX (stable dosing [8 mg/week] for a minimum of 3 months) at screening. The exclusion criteria were pregnancy, breastfeeding, active infection, or significant concomitant disease. Patients were only enrolled if they had normal creatinine clearance, because the administration of a contrast agent was part of the MRI protocol. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The study was approved by the Ethics Committee of the University of Tokyo. All patients provided written informed consent prior to participation. Figure 1 shows the CONSORT flowchart.

Study protocol

This study was registered with the UMIN Clinical Trials Registry (UMIN000005773) and conducted between June 2011 and August 2013. This was an open-label study. Patients were assigned to receive either MTX ($\geq$10 mg/week) plus ETN (50 mg/week) or MTX monotherapy ($\geq$10 mg/week) for 52 weeks. Allocation to each group was assigned alternately after determining eligibility criteria. The primary endpoint was variations in MRI-determined cartilage volumes. The secondary endpoint was the presence of remission at week 52. Definitions of remission used in this study were DAS-28 remission <2.6 and the ACR/EULAR definitions of remission using a 28-joint count [18], namely the Boolean-based definition for clinical trials, the index-based definition, and the simplified disease activity index (SDAI) $\leq$ 3.3 [19].

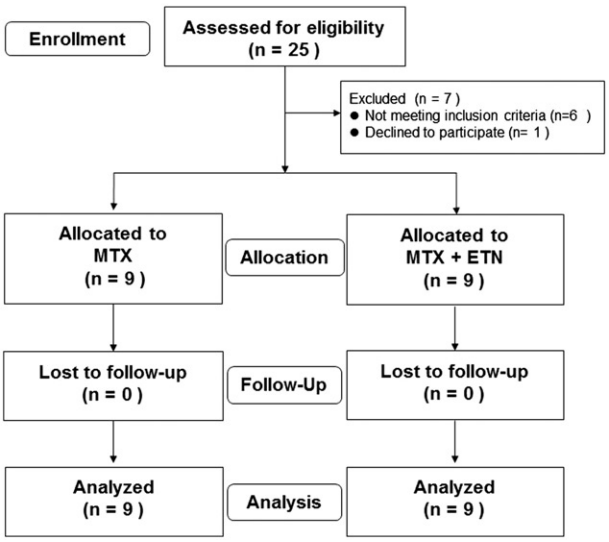

Figure 1. CONSORT flowchart of this study.

The background variables analyzed were age and duration of disease. Clinical evaluation included the assessment of erythrocyte sedimentation rate (ESR) and matrix metalloproteinase (MMP)-3, measurement of the number of swollen and tender joints, and self-assessment of pain and overall function at baseline and 52 months. The disease activity was also evaluated using the DAS-28, SDAI, and clinical disease activity index (CDAI) at baseline and 52 months [20]. Radiographs were taken at only baseline and scored independently by using the Genant-modified total sharp score by two trained readers blinded to the treatment group and clinical data [21].

MRI

MRI images were obtained by using a 3-T scanner (Philips Achieva 3T; Philips Electronics) with an eight-element sensitivity encoding phased array coil at baseline and after 12, 24, and 52 weeks. All patients were positioned consistently, with the joint space in the middle of the coil and the knee extended and slightly flexed. T1-weighted-fast field echo (FFE) sequences and contrast-enhanced proton density (PD)-weighted turbo spin-echo (TSE) were used in the sagittal plane. A 20-gauge needle infusion line was inserted in the right antecubital vein. Sixty seconds after the initiation of the enhanced PD-weighted TSE, a bolus of a Gd-DTPA contrast agent (0.1 mg/kg; Magnevist, Bayer Schering Pharma, Berlin, Germany) followed by a 15-mL saline chase was delivered at an injection rate of 5 mL/s. A summary of the MRI sequence parameters is given in supplementary table.

The software of MRI data analysis developed in-house running on Windows. The cartilage thickness is computed by the distance perpendicular from the bone surface to the cartilage surface by using scaled color mapping [22]. The detail of software is described in supplementary methods. The representative image is shown in Figure 2.

Each of six regions (the patellofemoral joint [2 sites], medial compartment [2 sites], and lateral compartment [2 sites]) was graded as follows: 0 = no erosions; 1 = non-penetrating pannus-induced cartilage erosions; 2 = penetrating pannus-induced cartilage erosions; 3 = presence of bone erosions. An erosion score, calculated as the sum of the grades, was calculated [23].

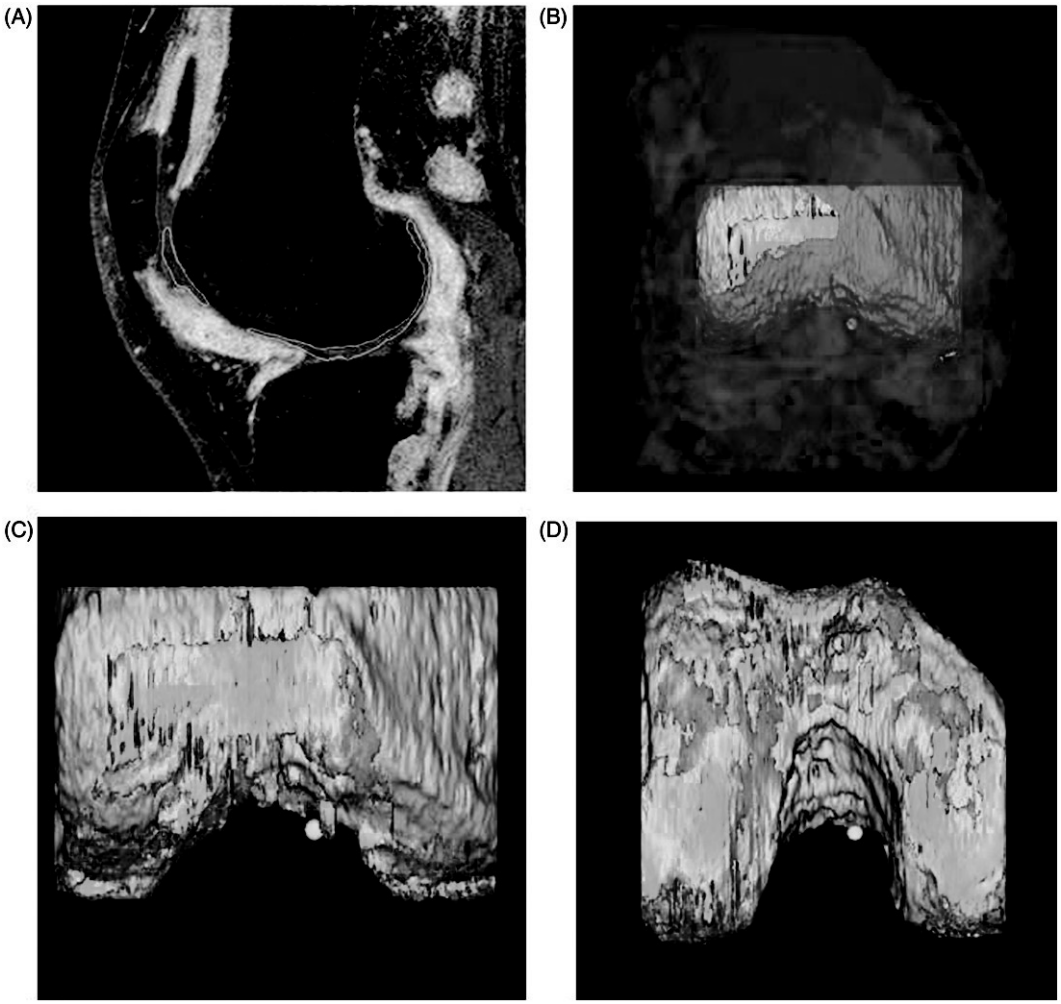

Figure 2. The representative images of this study. (A) Knee magnetic resonance imaging using a sagittal contrast-enhanced proton density-weighted turbo spin echo sequence (delineation of the cartilage was automatically segmented by the active contour model and the brightness of voxels). (B) Three-dimensional reconstruction of the enhanced synovial membrane (front view). (C) Three-dimensional reconstruction of the bone and cartilage (front view: cartilage surface on scaled color mapping). (D) Three-dimensional reconstruction of the bone and cartilage (bottom view).

Statistical analysis

The significance of the differences in the baseline characteristics between groups was tested using the Mann–Whitney *U*-test and the Fisher exact test. The changes from baseline in MRI-determined synovial membrane and cartilage volumes at each time point (12, 24, and 52 weeks) were tested using the Wilcoxon signed-rank test. We also used the Wilcoxon signed-rank test for analysis of volume change rate (%). Volume change rate (%) was calculated by the following equation: volume change rate = {(baseline volume) − (volume at each time point)}/(baseline volume) × 100. MRI-determined synovial membrane and cartilage volumes in both the groups were compared using the Mann–Whitney *U*-test. Significant differences in synovial membrane and cartilage volume reduction were tested using the rank-transformed analysis of covariance (ANCOVA).

Correlations among the volume change rate of cartilage at 52 weeks and synovial membrane at 12, 24, and 52 months were investigated by Spearman's test of rank correlation. The proportions of participants achieving remission of disease activity were compared with the Fisher exact test. Statistically optimal threshold values are described in supplementary methods. All statistical tests were performed at a significance level of 0.05 (two-sided) and were not adjusted for multiple testing. Data analyses were performed using SAS version 9.1.3 (SAS Institute Inc., Cary, NC).

Results

The study included 18 patients: 9 patients receiving MTX monotherapy and 9 patients receiving MTX + ETN therapy. Tables 1 and 2 show the demographic characteristics of the patients. No significant differences were identified between the groups.

Quantitative cartilage volume

In both the groups, MRI-determined cartilage volumes began to decrease at 12 weeks. There was a significant reduction from baseline in the mean cartilage volume in both groups (Figure 3(A)). The cartilage volume changes from baseline were not significantly different between the groups at 12 weeks (MTX: $-1.3 \pm 1.4\,cm^3$, MTX + ETN: $-1.1 \pm 1.9\,cm^3$, $p = .30$), 24 weeks (MTX: $-1.9 \pm 1.6\,cm^3$,

MTX + ETN: $-1.7 \pm 2.3\,cm^3$, $p = .44$), or 52 weeks (MTX: $-2.4 \pm 1.6\,cm^3$, MTX + ETN: $-2.3 \pm 2.3\,cm^3$, $p = .55$).

The cartilage volume change rates (%) from baseline were not also significantly different between the groups at 12 weeks (MTX: $9.7 \pm 15.0\%$, MTX + ETN: $11.9 \pm 9.6\%$, $p = .72$), 24 weeks (MTX: $15.3 \pm 17.2\%$, MTX + ETN: $16.3 \pm 10.1\%$, $p = .89$), or 52 weeks (MTX: $20.6 \pm 17.2\%$, MTX + ETN: $20.8 \pm 9.7\,cm^3$, $p = .97$; Figure 3(B)).

Table 1. Patient demographic and clinical characteristics at baseline.

	MTX ($n = 9$)	ETN + MTX ($n = 9$)	p-Value
Women, n	9	9	1.0
Age, years	54.4 (13.6)	52.2 (10.6)	.45
BMI, kg/m^2	23.5 (4.3)	21.2 (2.5)	.19
Disease duration, years	12.0 (8.7)	15.5 (7.0)	.36
Tender joint count	3.6 (2.6)	2.3 (1.5)	.24
Swollen joint count	1.8 (0.8)	1.9 (1.2)	.82
CRP level, mg/dL	0.6 (0.8)	0.7 (1.1)	.88
ESR, mm/h	29.9 (18.9)	34.3 (21.5)	.65
MMP-3 level, ng/mL	86.9 (55.6)	108.8 (79.2)	.51
DAS-28-ESR	4.4 (0.7)	4.0 (0.9)	.38
SDAI	13.2 (6.3)	9.8 (5.1)	.22
CDAI	12.6 (6.4)	9.1 (4.1)	.22
Genant-modified total sharp score	37.9 (38.9)	54.4 (35.7)	.36
Erosion score	17.1 (18.3)	24.7 (15.6)	.36
JSN score	20.8 (20.8)	29.8 (20.2)	.37
Knee cartilage volume, cm^3	11.1 (3.0)	10.8 (2.1)	.86
Knee synovial membrane volume, cm^3	6.6 (8.6)	9.2 (9.0)	.56
Bone erosion score	2.4 (2.9)	2.7 (3.9)	.89

Except where indicated otherwise, values represent mean (S.D.).
No significant differences were seen between the groups at baseline.
JSN: joint space narrowing.

Table 2. The Spearman correlation coefficient among the volume change rate of cartilage at 52 weeks and synovial membrane at 12, 24, and 52 weeks.

	Synovial membrane at 12 weeks	Synovial membrane at 24 weeks	Synovial membrane at 52 weeks
MTX ($n = 9$)			
Cartilage at 52 weeks	−0.95	−0.89	−0.93
(p-Value)	(<.0001)	(.0014)	(.0003)
ETN + MTX ($n = 9$)			
Cartilage at 52 weeks	−0.97	−0.94	−0.87
(p-Value)	(<.0001)	(.0016)	(.0021)

Quantitative synovial membrane volume

In both groups, MRI-determined synovial membrane volumes began to decrease at 12 weeks. There was a significant reduction from baseline in the mean synovial membrane volume in both groups (Figure 4(A)). The synovial membrane volume changes from baseline were not significantly different between the groups at 12 weeks (MTX: $-2.4 \pm 2.7\,cm^3$, MTX + ETN: $-4.1 \pm 4.0 cm^3$, $p = .30$), 24 weeks (MTX: $-3.3 \pm 3.6\,cm^3$, MTX + ETN: $-5.4 \pm 6.1\,cm^3$, $p = .39$), or 52 weeks (MTX: $-4.0 \pm 4.7\,cm^3$, MTX + ETN: $-6.4 \pm 6.6\,cm^3$, $p = .41$).

The synovial membrane volume change rates (%) from baseline were not also significantly different between the groups at 12 weeks (MTX: $51.1 \pm 18.0\%$, MTX + ETN: $46.6 \pm 12.7\%$, $p = .55$), 24 weeks (MTX: $62.5 \pm 19.3\%$, MTX + ETN: $70.6 \pm 18.6\%$, $p = .38$), or 52 weeks (MTX: $72.0 \pm 17.1\%$, MTX + ETN: $78.2 \pm 14.7\%$, $p = .42$; Figure 4(B)).

Correlation between the volume change rates of cartilage and synovial membrane

There was significant correlation between the volume change rates of cartilage at 52 weeks and synovial membrane at each time point on MTX or MTX + ETN, respectively. The correlation coefficients of the volume change rate of cartilage at 52 weeks with synovial membrane at 24 weeks on MTX and 52 weeks on MTX + ETN were very strong.

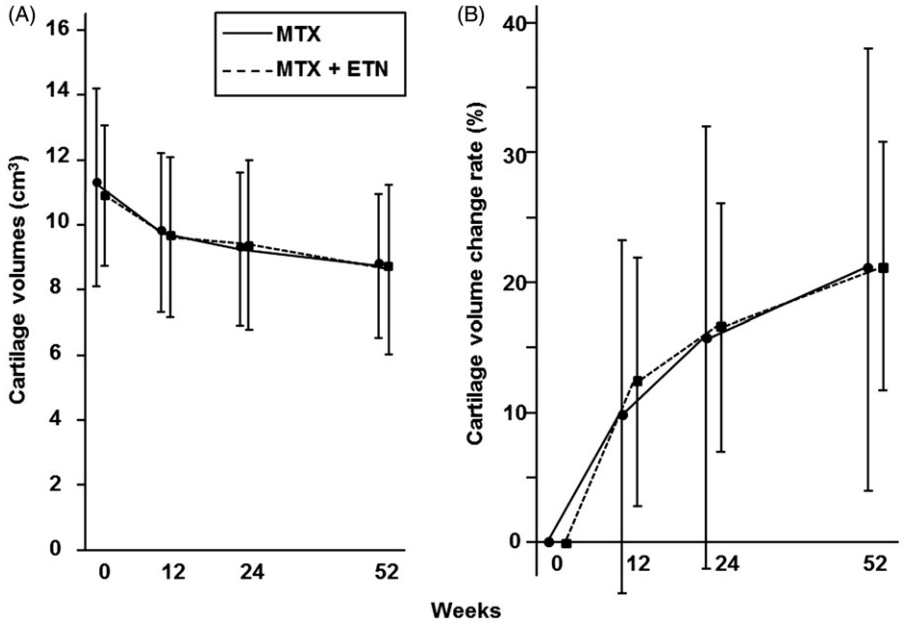

Figure 3. (A) Time course of magnetic resonance imaging (MRI)-determined cartilage volume in each treatment group. Comparison between the methotrexate (MTX) monotherapy group and the methotrexate plus etanercept (MTX + ETN) group. (B) Time course of the cartilage volume change rate (%) from baseline in each treatment group. Comparison between the methotrexate (MTX) monotherapy group and the methotrexate plus etanercept (MTX + ETN) group.

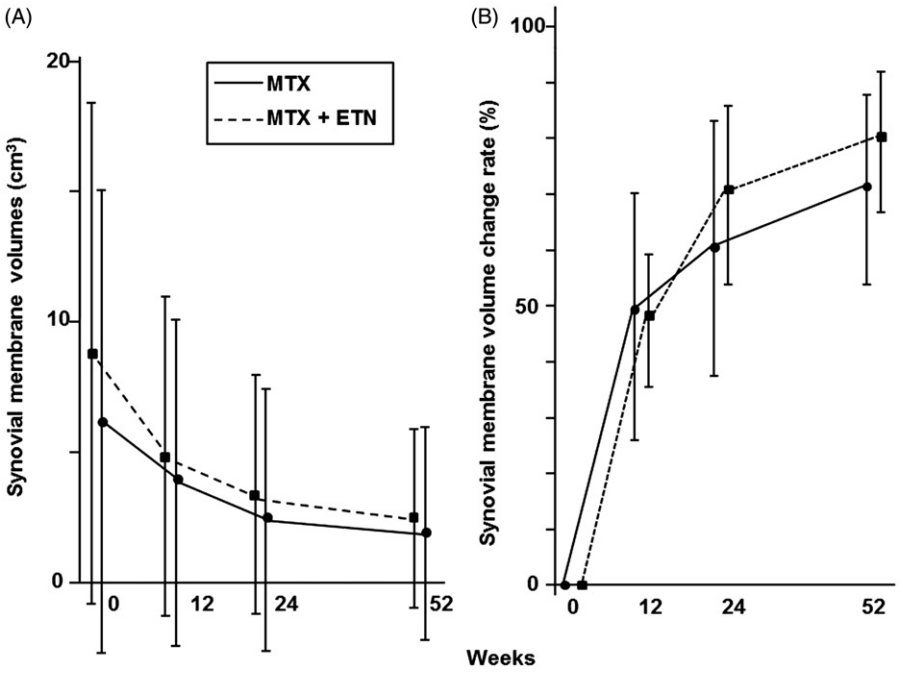

Figure 4. (A) Time course of magnetic resonance imaging (MRI)-determined synovial membrane volume in each treatment group. Comparison between the methotrexate (MTX) monotherapy group and the methotrexate plus etanercept (MTX + ETN) group. (B) Time course of the synovial membrane volume change rate (%) from baseline in each treatment group. Comparison between the methotrexate (MTX) monotherapy group and the methotrexate plus etanercept (MTX + ETN) group.

Otherwise, the correlations were excellent with both treatment groups.

Semi-quantitative MRI assessment of bone erosions

At 52 weeks, there was no significant progression in the mean bone erosion scores of either group (MTX: -0.2 ± 0.4, MTX + ETN: -0.1 ± 0.3, $p = .55$).

Achieving remission of disease activity

At 52 weeks, the proportion of participants who achieved DAS-28 remission (<2.6) was not significantly different between the groups (MTX: 2 of 9 [22.2%], MTX + ETN: 5 of 9 [55.5%], $p = .33$). The Boolean-based definition was not significantly different between the groups (MTX: 2 of 9 [22.2%], MTX + ETN: 3 of 9 [33.3%], $p = 1.00$). The proportion of participants who showed SDAI remission (≤ 3.3) was not significantly different between the groups (MTX: 2 of 9 [22.2%], MTX + ETN: 3 of 9 [33.3%], $p = 1.00$).

Discussion

To our knowledge, this is the first study to systematically evaluate the association between MRI-determined synovial membrane and cartilage volumes measured by a semi-automated software on high-resolution knee MRI using data from an interventional clinical trial including patients with RA. MRI is more sensitive than radiography at assessing disease activity [24]. Contrast-enhanced MRI allows estimation of volumes of inflamed synovial membrane [25]. These MRI-determined volumes have been shown to be closely related to histopathological signs of synovitis [26]. Several synovial membrane volume quantification methods have been introduced in patients with RA. A semiautomatic 'enhancement threshold' method, based on computerized counting of voxels with a certain post-Gd signal intensity increase, has been used by one of the groups [27]. However, no established quantification method is available for determining the knee cartilage and synovial membrane volumes simultaneously on MRI in patients with RA. Evaluating the cartilage and synovial membranes simultaneously using our developed software enabled us to examine the correlation of distinct features of RA, which may lead to a better understanding of the RA pathophysiology. Therefore, we assessed the reference standard technique of MRI by means of the CV% of the repeated cartilage and synovial membrane volumes by using our system. As a result, the present system has been confirmed to provide accurate and objective measurements.

To our knowledge, no longitudinal studies have assessed the knee cartilage volume on MRI in patients with RA. Several studies for osteoarthritis (OA) suggest that changes of knee cartilage volume of -4% to -8% occur per year [28–30]. In contrast to these studies in OA subjects, we found that in a group of 18 RA patients, knee cartilage was lost at an average rate of about 20% per year. Thus, RA patients lose knee cartilage at an average annual rate of 20%, approximately 2.5–4 times the rate observed in OA patients.

The TEMPO study is a major clinical trial in patients with RA. In that study, patients with RA were randomly allocated to one of three groups (MTX only, ETN only, or MTX + ETN), and the outcomes were compared in a double-blinded manner for 3 years. MTX + ETN therapy was

superior to MTX monotherapy in terms of controlling disease activity and suppressing the progression of articular destruction [10]. However, in our study there were no significant differences in disease activity control or the progression of articular cartilage destruction between MTX monotherapy and MTX + ETN. This difference was probably due to the following limitations. The number of patients allocated to each treatment group was small, and adequate analysis and comparison of therapy characteristics could not be examined in detail; thus, no significant differences were noted in the cartilage volume changes from baseline. Additionally, there was no significant progression in the mean bone erosion score in each treatment group. Other limitation is that pain evaluation of the knee alone has not been done. Thus, it is insufficient consideration of the relation between MRI and clinical symptoms.

However, there was a strong correlation between the annual volume change rate of cartilage and the volume change rate of the synovial membrane at each time point (12, 24, and 52 weeks) in both groups. The volume change rate of the synovial membrane at 12 weeks had the strongest correlation coefficient in each treatment group (MTX: $r = -0.95$, MTX + ETN: $r = -0.97$). These data suggest that there is a strong association between cartilage destruction and regulation of synovial inflammation in the early stage of the disease. Therefore, this study provides useful insights in the structural assessment of patients with RA.

In conclusion, we conducted an open-label study that revealed clinically important information about the characteristics of knee joint destruction in patients with RA and determined the potential usefulness of a semi-automated MRI analysis software. Further randomized, prospective large-scale studies are required to examine the structural assessment of knee MRIs.

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Conflict of interest

H. Oka report grants from Teijin Pharma Limited., grants from Pfizer Inc., grants from Fujifilm Medical Co., Ltd., grants, personal fees from AYUMI Pharmaceutical Corporation, grants, personal fees from Nippon Zoki Pharmaceutical Co., Ltd., grants, personal fees from Ono Pharmaceutical Co., Ltd., grants from Eli Lilly Japan K.K., outside the submitted work; Y. Kadono, S. Ohashi, T. Yasui, K. Ono, and J. Nishino have nothing to disclose; K. Matsudaira received the research grant from Ministry of Health, Labour and Welfare for the submitted work; grant support including an endowed chair from Sumitomo Dainippon Pharma Co., Ltd. and Okamura Corporation; grant support including an endowed chair and lecture fees from AYUMI Pharmaceutical Corporation, Nippon Zoki Pharmaceutical Co., Ltd., Ono Pharmaceutical Co., Ltd., Eli Lilly Japan K.K., Astellas Pharma Inc., Toto Ltd., and Eisai Co., Ltd.; lecture fees from Pfizer Japan Inc., Hisamitsu Pharmaceutical Co., Inc., Janssen Pharmaceutical K.K., Kaken Pharmaceutical Co., Ltd., Teijin Pharma Limited; and lecture fees and advisory fees from Shionogi & Co., Ltd., outside the submitted work; S. Tanaka received personal fees for expert testimony from Amgen Inc., Asahi Kasei Pharma Corporation, Amgen Astellas BioPharma K.K., Ono Pharmaceutical Co., Ltd., KYOCERA Medical Corporation, Daiichi Sankyo Company, Limited, Teijin Pharma Limited., Eli Lilly Japan K.K., and Pfizer Japan Inc.; endowments from Astellas Pharma Inc., AYUMI Pharmaceutical Corporation, Pfizer Japan Inc., Bristol-Myers Squibb, Daiichi Sankyo Company, Limited, and Chugai Pharmaceutical Co., Ltd.; and grants from The Japan Agency for Medical Research and Development (AMED), Japan Society for the Promotion of Science (JSPS)/Grant-in-Aid for Scientific Research (A), and Japan Society for the Promotion of Science (JSPS)/Grant-in-Aid for Exploratory Research outside the submitted work.

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Assessment of potential risk factors for new onset disabling low back pain in Japanese workers: findings from the CUPID (cultural and psychosocial influences on disability) study

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Abstract

Background: Most studies of risk factors for new low back pain (LBP) have been conducted in Western populations, but because of cultural and environmental differences, the impact of causal factors may not be the same in other countries. We used longitudinal data from the Cultural and Psychosocial Influences on Disability (CUPID) study to assess risk factors for new onset of disabling LBP among Japanese workers.

Methods: Data came from a 1-year prospective follow-up of nurses, office workers, sales/marketing personnel, and transportation workers, initially aged 20–59 years, who were employed in or near Tokyo. A baseline questionnaire included items on past history of LBP, personal characteristics, ergonomic work demands, and work-related psychosocial factors. Further information about LBP was collected at follow-up. Analysis was restricted to participants who had been free from LBP during the 12 months before baseline. Logistic regression was used to assess baseline risk factors for new onset of disabling LBP (i.e. LBP that had interfered with work) during the 12 months of follow-up.

Results: Among 955 participants free from LBP during the 12 months before baseline, 58 (6.1%) reported a new episode of disabling LBP during the 12-month follow-up period. After mutual adjustment in a multivariate logistic regression analysis, which included the four factors that showed associations individually ($p < 0.1$) in analyses adjusted only for gender and age, the highest odds ratio (OR) was for past history of LBP (2.8, 95% [confidence interval {CI}]: 1.6–4.9), followed by working ≥60 h per week (1.8, 95% CI: 1.0–3.5) and lifting weights ≥25 kg by hand (1.6, 95% CI: 0.9–3.0). When past history of LBP was excluded from the model, ORs for the remaining risk factors were virtually unchanged.

Conclusions: Our findings suggest that among Japanese workers, as elsewhere, past history of LBP is a major risk factor for the development of new episodes of disabling back pain. They give limited support to the association with occupational lifting that has been observed in earlier research, both in Japan and in Western countries. In addition, they suggest a possible role of long working hours, which merits further investigation.

Keywords: New onset, Disabling low back pain, Prospective study, Risk factors, Japanese workers, Symptom-free

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Background

Low back pain (LBP) affects most adults at some point in their lives, some 85–95% of cases being classed as 'non-specific' (i.e. without identifiable underlying pathology) [1, 2]. In recent decades, it has consistently been the leading cause globally of years lived with disability [3], and in Japan, it is one of the most common causes of disability, with a reported lifetime prevalence of more than 80% [4]. In the workplace, it is a costly problem, not only impairing the health of employees, but also reducing productivity [5]. The largest societal costs arise from cases in which the pain is disabling [6].

Various risk factors for the development of LBP have been identified previously, including mechanical stress from occupational activities such as lifting, bending, twisting and manual handling [7], and also psychosocial factors such as low mood, somatizing tendency (a tendency to worry about common somatic symptoms), job dissatisfaction, and adverse health beliefs about the causes and prognosis of back disorders [7–12]. Moreover, epidemiological studies indicate that most people with a history of LBP experience a recurrence within a year [13–16]. Thus, the occurrence of LBP is an important predictor of future episodes [7, 8, 17–20].

Most of the research on these risk factors has been conducted in Western populations, but it is possible that because of cultural and environmental differences, their impacts are not the same in other countries [21]. In an earlier prospective cohort study of Japanese workers who had been symptom-free for at least 1 year, we found that, in accordance with observations in Western populations [7, 22–24], past history of LBP, interpersonal stress at work, and frequent occupational lifting were all important predictors of disabling LBP [25]. Before that study, risk factors for new onset LBP, and in particular the role of psychosocial aspects of work, had not been properly assessed through prospective epidemiological research in Japan, and there remains a need for further investigation to confirm its findings.

We therefore conducted a new longitudinal study, as part of an international investigation of risk factors for musculoskeletal pain and associated disability, the Cultural and Psychosocial Influences on Disability (CUPID) study, which focused on workers aged 20–59 years from 47 occupational groups in 18 countries [26–30]. Using data from the CUPID study, we again assessed risk factors for new onset of disabling LBP among Japanese workers.

Methods

Study design

Our target population for the present study was Japanese workers. We used data from a 1-year prospective follow-up of Japanese participants in the CUPID study, which were collected from four groups of workers employed in or near Tokyo: nurses from a university hospital; office workers in administrative and clerical jobs at the same hospital, four pharmaceutical companies and a privately-owned trading company; sales/marketing personnel from six pharmaceutical companies; and transportation workers (mainly lorry drivers and loaders) from two courier companies transporting baggage and mail.

Data collection

At each participating organization, a self-administered questionnaire with a covering letter from the study team was distributed to all employees in specified jobs. Workers were asked to return the completed questionnaire by post directly to the study administration office, including their name and mailing address for the purpose of follow-up. During 2009, a total of 3187 baseline questionnaires were distributed (nurses: 1074; office workers: 425; sales/marketing personnel: 380; transportation operatives: 1308), and of these, 2651 (83.2%) were completed and returned. After approximately 1 year, a follow-up questionnaire was sent to those participants who had returned the baseline questionnaire and consented to further contact. Of the 2651 participants who completed the baseline questionnaire, 1809 (68.2%) returned satisfactory follow-up questionnaires.

Baseline questionnaire

The baseline questionnaire comprised a Japanese translation of the original CUPID questionnaire [26], supplemented with additional questions for Japanese workers. Accuracy of translation was checked by independent back-translation into English.

Among other things, the questionnaire assessed the occurrence of LBP during the past 12 months, experience of LBP more than 12 months earlier (past history of LBP), and various individual and work-related risk factors [6]. LBP was defined as occurring in an area between the costal margin and inferior gluteal folds that was depicted in a diagram [26]. Severity of LBP was classified to four grades, based on a scheme devised by Von Korff: grade 0 (no LBP), grade 1 (LBP not interfering with work), grade 2 (LBP interfering with work), and grade 3 (LBP interfering with work and leading to sick-leave) [31].

The baseline questionnaire also assessed various personal characteristics (age, gender, age at which full-time education was finished, marital status, obesity [body mass index {BMI} ≥ 25 kg/m^2], smoking habits, habitual exercise), tenure of current job, hours worked per week, whether an average working day entailed lifting weights of ≥25 kg by hand, work-related psychosocial factors (interpersonal stress at work, inadequate breaks, job control, support from others when at work, job satisfaction), mental health, emotional trauma in childhood, awareness of colleagues

and family members with LBP, somatizing tendency, and adverse beliefs about LBP.

Smoking was quantified in terms of the Brinkman Index (calculated as the product of the total number of cigarettes smoked per day and the duration of smoking in years) [32]. Individuals with a Brinkman Index of ≥400 were classed as heavy smokers, and the remainder (including non-smokers) as non-heavy smokers.

Work-related psychosocial factors were each assessed through a single question. Questions on interpersonal stress and inadequate breaks were supplementary to the original English version of the CUPID questionnaire, and allowed for two possible answers – yes or no. Job control was defined as lacking when participants reported "seldom" or "never/almost never" having choice in deciding how to work. Support at work was classed as lacking in those who said that they "seldom" or "never" received help or support from colleagues when they encountered difficulties in their work. Job dissatisfaction was deemed to occur when in response a question about the extent to which they had been satisfied with their job as whole taking everything into consideration, participants answered "dissatisfied" or "very dissatisfied".

To assess mental health, relevant items from the MOS 36-item short-form health survey (SF-36) ver.1.2 were used [33, 34]. A score of 52 or lower on the SF-36 ver.1.2 mental health summary was taken to indicate depressed mood, 52 being the cut-point for diagnosing depression in Japanese adults [35].

Somatizing tendency was assessed using questions from the Brief Symptom Inventory [36], and was graded according to the number of symptoms (0, 1, ≥2) from a total of five (faintness or dizziness, pains in the heart or chest, nausea or upset stomach, trouble getting breath, hot or cold spells) that were reported as at least moderately distressing in the past week.

Adverse beliefs about LBP were assessed through questions derived from the Fear Avoidance Beliefs Questionnaire [37]. Participants were classed as having adverse beliefs about physical activity if they completely agreed that for someone with LBP, physical activity should be avoided as it might cause harm and that rest is needed to get better. They were deemed to have adverse beliefs about work-relatedness if they completely agreed that LBP is commonly caused by work. And they were considered to have adverse beliefs about prognosis if they completely agreed that neglecting LBP can cause permanent health problems and completely disagreed that such problems usually get better within 3 months.

Follow-up questionnaire

The follow-up questionnaire included items on any change of job since baseline, and the presence and severity of LBP in the past 12 months. The severity of LBP was graded in the same way as at baseline.

Eligibility criteria

In our analysis for this report, we restricted our attention to participants who had been free from LBP for the past 12 months at baseline, and who did not change their job during the follow-up period.

Outcome

The outcome of interest was any new onset of disabling LBP during the 12 months of follow-up, where pain was defined as disabling if it had interfered with work (grade 2 or 3).

Statistical methods

Descriptive statistics were calculated, and then logistic regression was used to explore associations with risk factors. These were summarised by odds ratios (ORs) with 95% confidence intervals (CIs). First, each risk factor was analysed separately: a) with adjustment only for age and gender; and b) with adjustment also for past history of LBP, which had been identified as an important risk factor in earlier research including our own [7, 25]. Risk factors with p-values <0.1 when adjusted only for age and gender were then taken forward for inclusion in a single multivariate model with mutual adjustment. The software package SAS Release 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses.

Ethical approval

Ethical approval for the study was obtained from the ethics committees of the University of Tokyo Hospital and review board of the Japan Labour Health and Welfare Organization. All participants provided written informed consent.

Results

Baseline characteristics of the study participants

Of the 1809 participants who responded to the 1-year follow-up questionnaire, 955 had reported no LBP during the previous 12 months at baseline, and were included in subsequent analyses (Fig. 1). Their mean (standard deviation: SD) age at baseline was 36.7 (9.9) years, most were male (n = 651; 68.3%), and they had a mean (SD) BMI at baseline of 22.2 (3.0) kg/m^2. The proportions by occupational group were: transportation operatives (38.1%), nurses (23.8%), sales/marketing personnel (21.1%), and office workers (16.7%).

Incidence of new onset disabling low back pain

Among the 955 eligible participants, 58 (6.1%) reported a new episode of disabling LBP during the 12-month follow-up period. Their mean (SD) age at baseline was 34.4 (8.7) years, and most were male (62.1%). In most cases the severity was graded 2 (n = 43, 74.1%), but 15 (25.9%) had grade 3 LBP. Among the latter, total sick-leave during the 12 months was mostly 1–5 days (73.3%), while the rest had been absent for 6–30 days (26.7%).

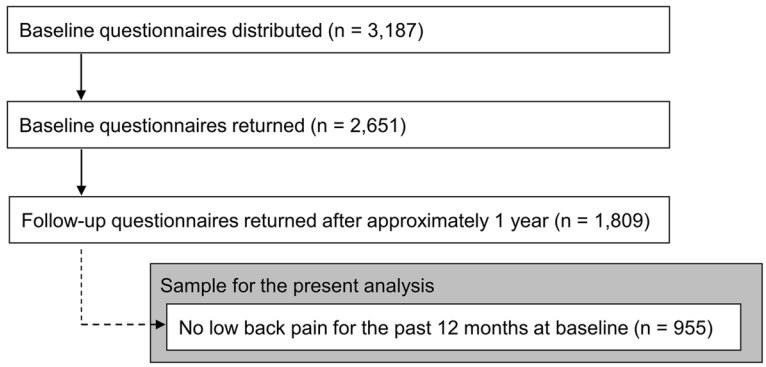

Fig. 1 Flow chart of the sample selection for the present analysis

Association of new onset disabling low back pain with risk factors

Table 1 shows ORs for the onset of disabling LBP, after adjustment for age and gender, and then also for past history of LBP. In the analyses adjusted only for gender and age, four factors were associated with *p*-values <0.1, and thus met the criterion for inclusion in subsequent multivariate analysis. These were: past history of LBP (OR: 2.6, 95% CI: 1.5–4.6), working ≥60 h per week (OR: 2.1, 95% CI: 1.1–4.0), lifting weights of ≥25 kg by hand (OR: 1.9, 95% CI: 1.1–3.3), and inadequate breaks (OR: 1.8, 95% CI: 1.0–3.1). When associations were adjusted also for past history of LBP, working ≥60 h per week (OR: 2.0, 95% CI: 1.1–3.9) and lifting weights ≥25 kg by hand (OR: 1.9, 95% CI: 1.1–3.3) remained the strongest risk factors.

After mutual adjustment in multivariate logistic regression analysis, the ORs were a little lower overall, but with a similar pattern to that in the earlier analyses (Table 2). The highest OR was for past history of LBP (OR: 2.8, 95% CI: 1.6–4.9), followed by working ≥60 h per week (OR: 1.8, 95% CI: 1.0–3.5) and lifting weights ≥25 kg by hand (OR: 1.6, 95% CI: 0.9–3.0). When past history of LBP was excluded from the model, ORs were virtually unchanged.

Discussion

These results indicate that past history of LBP and working long hours were risk factors for the new onset of disabling LBP among Japanese workers who had been symptom-free during the 12 months before baseline. In addition, risk was increased in participants who reported occupational lifting, although not significantly at a 5% level.

In the present investigation, the incidence of disabling LBP was relatively low (6.1%) which may reflect our strict definition of disability (interference with work), as well as the requirement for a long symptom-free period before baseline. It has previously been proposed that an episode of LBP can be classed as new if it occurs after a period of at least 1–3 months without symptoms [38]. However, LBP is commonly recurrent within a year [13–16]. Moreover, a recent systematic review indicated that only 33% of patients in a primary care setting have recovered from non-specific LBP at a year after onset, whereas approximately 65% still experience pain [39]. Give these findings, we felt justified in requiring a 12-month symptom-free period at baseline, when exploring risk factors for new episodes, although we recognize that the criteria are to some extent arbitrary. In our earlier study, the incidence of new disabling LBP during 2 years of follow-up in workers who had been without LBP for more than 12 months before baseline was 3.9%, which is a little lower than in the current investigation [25].

We found that past history of LBP was the strongest and most significant risk factor for new disabling LBP, with an OR of almost three. This accords with our earlier study in Japan [25], and also with observations in Western populations [7, 8, 17–20]. It may be that the occurrence of a back problem renders an individual more vulnerable to future episodes of LBP (e.g. through changes in spinal structure and function or in the central processing of pain). Alternatively, the association might reflect continuing exposure to risk factors that were responsible for the initial development of the back problem. In our analysis, the association with past history of LBP was present after adjustment for other risk factors, but there may have been other important determinants of LBP that we did not assess.

In addition to past history of LBP, working ≥60 h per week and lifting weights of ≥25 kg by hand carried significantly elevated risk in analyses that adjusted for age and gender, the association with occupational lifting falling just short of significance when risk estimates were mutually adjusted. Biomechanical loading of the spine from manual handling tasks such as lifting, has been found experimentally to be greater in the presence of demands for mental processing that induce stress [24, 40]. Moreover, working overtime has been reported to increase

Table 1 Associations of risk factors at baseline with new onset of disabling low back pain

Risk factor	[a]n (%)	[b]OR	(95% CI)	[c]OR	(95% CI)
Age					
< 40 years	618 (65.2)				
40–49 years	200 (21.1)				
≥ 50 years	130 (13.7)				
Female gender	302 (31.7)				
Past history of LBP	313 (33.8)	2.6	(1.5–4.6)*		
Finished full-time education before age 19 years	304 (31.9)	1.4	(0.8–2.6)	1.4	(0.7–2.7)
BMI ≥ 25 kg/m^2 (obesity)	133 (14.2)	1.1	(0.5–2.5)	0.9	(0.4–2.1)
< 5 h sleep per day	82 (8.7)	1.8	(0.8–3.9)	1.5	(0.6–3.4)
Not married	445 (46.9)	0.8	(0.4–1.4)	0.8	(0.4–1.4)
Heavy smoker	133 (13.9)	0.8	(0.4–1.5)	0.6	(0.2–1.9)
Employed in current job for <1 year	96 (10.1)	1.2	(0.5–2.7)	1.3	(0.6–3.1)
Work ≥60 h per week	364 (38.8)	2.1	(1.1–4.0)*	2.0	(1.1–3.9)*
Lift weights ≥25 kg by hand	452 (47.3)	1.9	(1.1–3.3)*	1.9	(1.1–3.3)*
Aware of colleague(s) with LBP	687 (72.5)	1.2	(0.6–2.2)	1.1	(0.6–2.2)
Aware of family member(s) with LBP	301 (31.5)	1.2	(0.7–2.2)	1.1	(0.6–2.0)
Irregular work shifts	304 (31.9)	1.1	(0.6–2.0)	1.1	(0.6–1.9)
Interpersonal stress at work	458 (48.0)	1.3	(0.7–2.2)	1.1	(0.6–1.9)
Inadequate breaks at work	507 (53.1)	1.8	(1.0–3.1)	1.6	(0.9–2.9)
Lack of job control	347 (36.4)	0.9	(0.5–1.5)	0.8	(0.5–1.5)
Lack of support at work	72 (7.7)	2.0	(0.8–4.6)	1.9	(0.8–4.6)
Dissatisfied with job	378 (39.7)	0.8	(0.4–1.4)	0.7	(0.4–1.3)
Low mood	265 (28.0)	1.0	(0.6–1.9)	1.0	(0.5–1.8)
Regular exercise < once per week	652 (69.3)	1.0	(0.6–1.8)	0.9	(0.5–1.7)
Emotional trauma in childhood	66 (7.1)	2.0	(0.9–4.7)	1.7	(0.7–3.9)
Number distressing somatic symptoms					
0	760 (80.3)	1.0		1.0	
1	132 (13.9)	1.3	(0.6–2.6)	1.4	(0.7–2.9)
≥ 2	55 (5.8)	0.3	(0.0–1.9)	0.3	(0.0–2.0)
Adverse beliefs about LBP					
Work relatedness	306 (32.3)	1.3	(0.8–2.3)	1.3	(0.8–2.3)
Physical activity	208 (22.0)	1.0	(0.5–1.9)	1.1	(0.5–2.0)
Prognosis	155 (16.4)	0.8	(0.4–1.7)	0.9	(0.4–1.9)

Totals may not sum to 100% due to rounding
OR odds ratio; *CI* confidence interval; *LBP* low back pain
[a]Data on individual risk factors were missing for up to 29 participants. Each logistic regression analysis was limited to participants with complete information on all of the risk factors included in the relevant model
[b]Odds ratios (with 95% confidence intervals) adjusted for age and gender
[c]Odds ratios (with 95% confidence intervals) adjusted for age, gender and past history of LBP
*$P < 0.05$. A cut-point of $P < 0.1$ was adopted to select risk factors for inclusion in a subsequent multivariate model (see Table 2)

risk of musculoskeletal disorders such as LBP [41]. While excessive working hours, perhaps entailing physical exhaustion as well as mental strain, could of itself lead to LBP, it might also act by potentiating the risks from spinal strain as a consequence of heavy lifting.

Long working hours may also reflect an element of "workaholism" in which an employee, whether for personal reasons or in response to an over-demanding job, spends excessive time at work to the detriment of his or her personal life [42]. This too is a previously reported risk factor for disabling LBP [43].

An association with long working hours was not apparent in our earlier study [25]. On the other hand, that investigation found new incidence of disabling LBP

Table 2 Mutually adjusted associations of risk factors at baseline with new onset of disabling low back pain

Risk factor	[a]OR	(95% CI)	[b]OR	(95% CI)
Age				
< 40 years	1.0		1.0	
40–49 years	0.8	0.4–1.8	1.0	0.5–2.0
≥ 50 years	0.7	0.2–1.9	0.7	0.2–2.1
Female gender	1.4	0.7–2.8	1.5	0.8–3.0
Work ≥60 h per week	1.8	1.0–3.5	1.9	1.0–3.6
Lift weights ≥25 kg by hand	1.6	0.9–3.0	1.5	0.8–2.8
Inadequate break time at work	1.4	0.7–2.6	1.4	0.8–2.7
Past history of LBP	2.8	1.6–4.9	–	–

Participants with missing data for any of the variables in the model were excluded

[a]Mutually adjusted odds ratios (with 95% confidence intervals) derived from a logistic regression model which included all of the variables for which results are presented

[b]Mutually adjusted odds ratios (with 95% confidence intervals) derived from a logistic regression model which included all of the variables for which results are presented but did not adjust for past history of LBP

aside was significantly related to interpersonal stress at work, a finding that was not replicated in the current analysis. These differences may reflect differing characteristics of the populations studied. For example, in the earlier investigation, the participants were mostly male (88.3%) and office workers (76.1%). Alternatively, they could have occurred by chance. They underline the need for replication of results, especially when multiple risk factors are examined without strong prior expectations, and there is therefore greater potential for false positive results.

That said, the findings of the present study are not clearly different from those in Western populations. Divergence from other countries in the factors affecting new onset of disabling LBP might perhaps have been expected as a consequence of cultural differences. However, a trend to westernization in Japan may have reduced those differences. Alternatively, our questionnaire may not have covered risk factors that would differ from those in other countries or cultures.

Some limitations of our investigation should be noted. First, the generalizability of the results may be limited because the study sample was not fully representative. For example, the proportion of female participants was small in comparison with that in the national workforce of Japan. Second, because information about exposures and symptoms was obtained by self-report, some degree of misclassification is likely. Physical exposures, such as heavy lifting, might be assessed better using objective measures. Because of constraints on the total length of the questionnaire, the ascertainment of interpersonal stress was based on a single question rather than the longer Brief Job Stress Questionnaire [44] that we had used to assess psychosocial factors including interpersonal stress in our earlier study. In addition, there is a possibility of recall bias, given that the presence and severity of LBP, both at baseline and follow-up, were ascertained retrospectively. For example, participants with physically demanding jobs may have been more likely to recall symptoms and difficulty with work. Third, because the outcome was relatively infrequent, statistical power was limited. Lastly, although the present analysis included most of the well-established risk factors for new onset LBP, as well as other potential risk factors that have been suggested by earlier studies, it is possible that some important determinants, perhaps distributed differentially by occupational group, were overlooked, leading to unrecognized residual confounding. Given these limitations, our results should be interpreted with caution.

Conclusion

In conclusion, our findings suggest that among Japanese workers, as elsewhere, past history of LBP is a major risk factor for the development of new episodes of disabling back pain. They give limited support to the association with occupational lifting that has been observed in earlier research, both in Japan and in Western countries. In addition, they suggest a possible role of long working hours, which merits further investigation.

Abbreviations

BMI: Body mass index; CI: Confidence interval; CUPID: Cultural and Psychosocial Influences on Disability; LBP: Low back pain; OR: Odds ratio; SD: Standard deviation; SF-36: MOS 36-item short-form health survey

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Availability of data and materials

The dataset analyzed for this paper was provided by one of our co-authors, Dr. Ko Matsudaira, principal investigator of CUPID Japan. For access to the dataset, please contact the corresponding author.

Authors' contributions

KM designed the study. TI translated the questionnaires into Japanese. MK, TI, KM, and DC wrote the first draft of the manuscript and revised drafts. AI managed data. TK and DC contributed to statistical analyses and interpretation of data. TS analysed the data. KM and DC reviewed the final version of the manuscript for its intellectual content. All authors read and approved the final version manuscript.

Ethics approval and consent to participate

Ethical approval for the study was obtained from the ethics committees of the University of Tokyo Hospital (approval number: 1877) and review board of the Japan Labour Health and Welfare Organization. All participants provided written informed consent.

Consent for publication
Not applicable.

Competing interests
KM received grant support including an endowed chair from AYUMI Pharmaceutical Corporation, Nippon Zoki Pharmaceutical Co., Ltd., ONO PHARMACEUTICAL CO., LTD., Eli Lilly Japan K.K., Sumitomo Dainippon Pharma Co., Ltd., Astellas Pharma Inc., TOTO LTD., OKAMURA CORPORATION, and Eisai Co., Ltd.; honoraria for lecturing from AYUMI Pharmaceutical Corporation, Nippon Zoki Pharmaceutical Co., Ltd., ONO PHARMACEUTICAL CO., LTD., Pfizer Japan Inc., Shionogi & Co., Ltd., Eli Lilly Japan K.K., Astellas Pharma Inc., HISAMITSU PHARMACEUTICAL CO., INC., Janssen Pharmaceutical K.K., KAKEN PHARMACEUTICAL CO., LTD., TEIJIN PHARMA LIMITED., Eisai Co., Ltd., and TOTO LTD.; and advisory fees from Shionogi & Co., Ltd., outside this study. These entities did not have any role in the study design; data collection, analysis, and interpretation; manuscript writing; and/or decision to submit for publication. MK, TS, TK, AI, TI, and DC have no competing interests to declare.

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Original Article

Epidemiology and psychological factors of whiplash associated disorders in Japanese population

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Abstract. [Purpose] This study was designed to examine the epidemiological background of Whiplash-associated disorders in Japanese adults and to investigate the psychological factors associated with prolonged treatment for Whiplash-associated disorders. [Subjects and Methods] An online survey was completed by 127,956 participants, of whom 4,164 had been involved in a traffic collision. A random sample of the collision participants (n=1,698) were provided with a secondary questionnaire. From the 974 (57.4%) participants who returned the questionnaire, 183 cases (intractable neck pain treated over a period of 6 months) and 333 controls (minor neck pain treated within 3 months) were selected. Among the control group, the psychological factors associated with prolonged treatment for Whiplash-associated disorders were investigated. [Results] Among the 4,164 collision participants, 1,571 (37.7%) had experienced Whiplash-associated disorders. The prevalence in the general population was 1.2% (1.3% in male and 1.0% in female). Significant differences were observed between the cases and controls for all psychological factors, although both groups had similar distributions of age and gender. [Conclusion] Poor psychological factors were associated with prolonged treatment for whiplash-associated disorders in Japanese adults. These psychological factors should be considered during the treatment of whiplash-associated disorders.
Key words: Whiplash-associated disorders, Psychological factors, Prolonged treatment

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INTRODUCTION

Whiplash-associated disorders (WAD) are the most common injury associated with car collisions in Japan and many Western countries[1, 2)]. However, there is no clear epidemiological data regarding the prevalence of WAD in Japanese adults. Although the prognosis of WAD is generally favorable, previous studies have found that up to 50% of the affected individuals are still symptomatic one year after the injury[3)]. In addition, there is evidence from previous studies that depression is associated with poor recovery from WAD[4, 5)]. However, the patient's poor psychological condition, such as depression and fear, actually refers to a hyperbolic negative perception of actual or anticipated pain[6)], and this perception can prolong WAD treatment. To our knowledge, the psychological factors in the Japanese population with WAD have not been studied, and are not clearly understood.

Therefore, this study aimed to evaluate the epidemiological background of WAD in Japanese adults. Furthermore, we

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investigated the psychological factors associated with prolonged treatment for WAD, and reported the descriptive statistics for these factors.

SUBJECTS AND METHODS

Details of the study population have been described previously[7]. Briefly, we conducted an online survey to assess the prevalence of WAD in the general population. Participants were recruited through an internet research company. The initial survey was conducted online from July 1, 2012 through July 17, 2012. A total of 127,956 respondents completed items. This study was approved by the ethics review board of the Japan Labour Health and Welfare Organization.

The participants who had been in a traffic collision were considered relevant (n=4,164). From this sample, 1,698 participants were randomly selected to participate in a secondary survey. Of the 974 (57.4%) participants who returned the secondary questionnaire, we excluded 44 participants who were not wearing a seatbelt when the collision occurred, as these were likely to have sustained serious injuries. From the 930 remaining subjects, 183 were included in our intractable group (neck pain treated over a period of 6 months) and 333 were included in the control group (minor neck pain treated within 3 months). There was no article defined the period of the early recovery of WAD. Thus we clinically decided that the upper limit of early recovery is 3 months and set as a control group for intractable group.

The questionnaire evaluated socio-demographic data, age, gender, weight, height, education (not college, college, or other), driving status, and whether the participant had been in a traffic accident. If participants had been injured in a traffic collision, the car crash severity (mild, moderate, or severe), presence or absence of WAD, and length of unemployment (none, 1–3 days, 4–7 days, 1–4 weeks, ≥1 month) were also evaluated in the initial survey. Body mass index (BMI; kg/m^2) was calculated using the self-reported weight and height; overweight was defined as BMI ≥25.

We evaluated kinesiophobia using the Tampa Scale of Kinesiophobia (TSK), which is one of the most frequently employed measures for assessing fear. Each 17-item questionnaire is measured on a four-point Likert scale, and scores range from 17 (no fear) to 68 (strong fear of re-injury)[8]. The Japanese version of TSK has been linguistically validated[9]. Pain catastrophizing was evaluated using the Pain Catastrophizing Scale (PCS)[10, 11], which is a 13-item self-reported tool that asks participants to reflect on past painful experiences and to indicate the degree to which they experience thoughts or feelings during pain. Scores are ranked on a 5-point scale, ranging from 0 (not at all) to 4 (always).

Depression was defined as a score of ≤52 on the SF-36 Mental Health summary (SF-36 MH, version 1.2), as this score is the established cutoff value for Japanese adults[12, 13]. Somatizing tendency was assessed using a subset of items from the Brief Symptom Inventory (BSI)[14]; the Japanese version has been linguistically validated[15]. Seven somatic symptoms (faintness or dizziness, pain in the heart or chest, nausea or upset stomach, difficulty breathing, numbness or tingling in parts of the body, weakness in parts of the body, and hot or cold spells) were assessed on a 5-point scale, ranging from 0 (not at all) to 4 (extreme). A BSI score ≥2 was considered indicative of somatization[14, 16].

We also used the EuroQol-5 dimension (EQ-5D) questionnaire to evaluate general quality of life (QOL)[17, 18]. The five-dimensional health care classification evaluates the patient's status regarding morbidity, self-care, usual activities, pain/discomfort, and anxiety/depression. Participants were asked to indicate their current health status by selecting the most appropriate of the three statements for each of the five QOL dimensions, where each statement represented an increasing degree of severity. These results were coded and converted into a score of utility, using a standard table of values.

Results were presented as frequencies and proportions (percentages), or as means and standard deviations (continuous variables). All statistical tests were performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). The χ^2 test was used for nominal and ordinal data, and one-way analysis of variance was used for scaled data. Differences were considered statistically significant at a p-value of <0.05.

RESULTS

Demographic data for the respondents (n=127,956) to the initial questionnaire are listed in Table 1. Of these respondents, 4,164 (3.3%) had been injured in a traffic collision, and the characteristics of the collision and subsequent injury are listed in Table 2. Of the participants who had been in a collision, 1,571 (37.7%) were diagnosed with WAD. The prevalence of WAD in the general population was 1.2% (1.3% in male and 1.0% in female) (Table 3). Significant differences were observed between the intractable group and the control group regarding TSK, PCS (total and each component), SF36-MH, BSI, and EQ-5D (Table 4). No significant difference was detected between the groups regarding age or gender.

DISCUSSION

Little epidemiological information is available regarding WAD in Japan. In this study, 4,164 participants reported being injured in a traffic collision, of whom 37.7% were diagnosed with WAD; a similar prevalence of WAD was reported in a previous study[2]. The present study also clarified the age-gender distribution of WAD in the Japanese population. If our results are extrapolated to the Japanese population using the 2010 census data[19], approximately 980,000 persons (590,000 male and 390,000 female) aged 20 years and older are affected by WAD.

Table 1. Characteristics of the initial survey respondents (n=127,956)

Age years, mean ± SD	47.7 ± 10.8
Male, n (%)	81,387 (63.6%)
Overweight (BMI ≥25), n (%)	30,556 (23.9%)
Education level, n (%)	
Not college	73,747 (57.6%)
College	53,445 (41.8%)
Other	764 (0.6%)
Driving status, n (%)	
No license or occasional driver	29,193 (22.8%)
Normal driver	95,377 (74.5%)
Professional driver	3,386 (2.7%)
Traffic accident, n (%)	
Collision	4,164 (3.3%)
Other	6,155 (4.8%)
None	9,475 (18.0%)

SD: standard deviation; BMI: body mass index

Table 2. Collision and injury related characteristics from the initial survey (n=4,164)

Car crash severity, n (%)	
Minor	956 (23.0%)
Moderate	1,387 (33.3%)
Severe	1,821 (43.7%)
WAD, n (%)	1,571 (37.7%)
Length of unemployment, n (%)	
None	2,838 (68.2%)
1–3 days	730 (17.5%)
4–7 days	152 (3.7%)
1–4 weeks	226 (5.4%)
≥1 month	218 (5.2%)

WAD: whiplash-associated disorder

Table 3. Prevalence of whiplash-associated disorders according to age and gender (n=127,956)

Age	Male		Female	
(years)	N	Prevalence (%)	N	Prevalence (%)
20–24	715	1.3	973	0.7
25–29	1,668	2.1	2,428	1.2
30–34	3,784	1.8	4,633	1.0
35–39	8,208	1.6	7,849	0.9
40–44	12,139	1.5	8,945	1.0
45–49	13,742	1.6	7,503	1.1
50–54	13,419	1.2	6,051	1.0
55–59	10,217	1.3	3,897	0.9
60–65	10,734	0.9	2,972	0.9
65–69	6,761	1.0	1,318	0.6
Total	81,387	1.3	46,569	1.0

Table 4. The characteristics and psychological factors of whiplash-associated disorder patients

	Cases (n=183)	Controls (n=333)
Age	44.8 ± 10.3	45.3 ± 11.7
Gender, male/female	124/59	242/91
TSK	44.0 ± 9.1	34.5 ± 9.5*
PCS	32.7 ± 10.6	17.5 ± 10.5*
rumination	14.8 ± 4.1	8.9 ± 4.8*
magnification	6.9 ± 3.0	3.8 ± 2.9*
helplessness	11.0 ± 4.9	4.9 ± 4.1*
SF-36 MH, n (%)		
≤52	99 (54.1%)	116 (34.8%)†
>52	84 (45.9%)	217 (65.2%)
BSI, n (%)		
≥2	157 (85.8%)	167 (50.2%)†
1	11 (6.0%)	38 (11.4%)
0	15 (8.2%)	128 (38.4%)
EQ-5D, mean (SD)	0.674 ± 0.178	0.923 ± 0.129*

TSK: Tampa Scale for Kinesiophobia; PSC: Pain Catastrophizing Scale; SF-36 MH: SF-36 Mental Health summary (version 1.2); BSI: Brief Symptom Inventory; EQ-5D: EuroQol-5 dimension questionnaire

Mean ± SD, *Statistical difference as determined by one-way analysis of variance ($p<0.01$); †Statistical difference as determined by χ^2 test ($p<0.01$)

Furthermore, we also investigated the psychological factors associated with prolonged treatment for WAD in Japanese adults. Using randomly selected participants who had been in a collision, we formed a sub-cohort of symptomatic WAD patients to evaluate their psychological factors. Intractable and control groups were evaluated for representative psychological factors and health-related QOL, and the results were compared. Significant differences were observed in catastrophizing and fear, which has also been reported in Western countries[20]. Interestingly, each of the psychological aspects were negative in the intractable group, which implies that poor psychological condition has a negative effect on WAD treatment. Similarly, a previous study in a Western country found that chronic whiplash syndrome is triggered by emotional discomfort and psychological distress[21]. In addition, individuals with somatization often complain of pain in various locations, functional disturbance of various organ systems, and are depressed or overwhelmed by these symptoms. Therefore, patients in this situation are thought to suffer from functional somatic syndrome[21], and their psychological factors likely affect their treatment for WAD. In the present study, the mean EQ-5D score for the intractable group was 0.674, which was similar to the previously reported score for chronic widespread pain (CWP)[22]. Thus, patients with WAD and chronic widespread pain experience a marked decrease in their QOL[23, 24].

This study has several limitations. Due to its cross-sectional design, we cannot comment on the causality of the relation-

ship between psychological factors and WAD treatment. In addition, our participants were internet research volunteers, who may not accurately represent the general population. For example, our participants were more likely to live in large cities compared to the general population. In addition, our respondents were more likely to have university-level or graduate-level education[25]. However, the effect of any potential selection bias on our results would be difficult to elucidate. Despite these limitations, this study could provide useful insights to orthopedic surgeons who are tasked with treating patients with WAD.

In conclusion, poor psychological condition was associated with prolonged treatment for WAD in Japanese adults. Therefore, psychological factors should be considered during the treatment of WAD.

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PLOS ONE

RESEARCH ARTICLE

The associations between magnetic resonance imaging findings and low back pain: A 10-year longitudinal analysis

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Abstract

Purpose

To conduct a 10-year longitudinal analysis of the relationship between magnetic resonance imaging (MRI) findings and low back pain (LBP).

Materials and methods

Ninety-one volunteers with a history of LBP, but without current LBP were recruited between 2005 and 2006. Participants' baseline demographics and MRI findings were recorded. All volunteers were invited for a follow-up MRI in 2016; of these, 49 volunteers (53.8%) participated in the follow-up. We enquired whether they had LBP history during the 10 years between the baseline and follow-up examinations. Sagittal T1 and T2-weighted MRI were used to assess the intervertebral space from T12/L1 to L5/S1. We evaluated the presence of disc degeneration by Pfirrmann's grading system, disc bulging, high intensity zone (HIZ), spondylolisthesis, and any type of Modic changes in the follow-up MRIs. We compared the follow-up MRI findings with the baseline findings; the progress of each finding over the 10 years were also compared between the groups with (n = 36) and without (n = 13) LBP.

Results

Average age of the study participants at follow-up was 44.8 years; 25 were female and 24 were male. Average age, sex, body mass index, and smoking habits of those who did and did not participate in the follow-up study, as well as the demographic characteristics of those who did and did not have LBP history during the 10 years, were not significantly different. Compared with the group without LBP history, the group that had LBP history during the 10 years did not have a significantly increased prevalence of disc degeneration, disc bulging, and HIZ in the follow-up and baseline MRIs. Spondylolisthesis and any type of Modic changes were also not associated with LBP history during the 10 years.

and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

Conclusions

Follow-up MRI findings consistent with Pfirrmann grading ≥4, disc bulging, HIZ, spondylolisthesis, and any type of Modic changes were not associated with LBP history during the 10 years between the baseline and follow-up study. The progresses of these findings were also not associated with the LBP history. In addition, baseline MRI findings were not associated with LBP history during the 10 years; therefore, our data suggest that baseline MRI findings cannot predict future LBP.

Introduction

Low back pain (LBP) is one of the most common causes of health disability, and continues to be the leading cause of disability over the last decade [1]. A Japanese population study reported that the lifetime prevalence of LBP was >80%, as in other industrialized countries [2].

Magnetic resonance imaging (MRI) is able to identify soft tissue such as disc, nerves, and muscles, which are among the possible sources of LBP; however, in some cases, MRI findings may not necessarily identify the source of LBP. Some reports have shown that disc degeneration was associated with LBP [3,4,5], while others have demonstrated no such relationship [6,7]. It has been suggested that symptoms of chronic LBP are often fluctuating, and that LBP is often demonstrated as a condition with patterns of exacerbation and remission [8]. We have reported that disc degeneration, disc bulging, and high-intensity zone (HIZ) were associated with previous history of LBP, and that patients with these findings are prone to develop severe LBP, unless they did not have current severe LBP [9]. However, these reports were related to cross-sectional studies.

There are a few longitudinal studies regarding the relationship between baseline MRI findings and future LBP [10, 11, 12]; however, there is only one longitudinal study about LBP reporting both baseline and follow-up MRIs [13]. The purpose of this study was to examine the longitudinal associations between MRI findings and LBP history during the 10 years between the baseline and follow-up study. The primary aim of this study was to investigate if the follow-up MRI findings and the progress of each finding were associated with a LBP history during the 10 years. The secondary aim was to investigate if the presence of MRI findings at baseline predicted future LBP.

Materials and methods

Study participants

As described in detail previously [9], between September 2005 and March 2006, we recruited volunteers who were also Kanto Rosai Hospital personnel to participate in the study. Ninety-one participants with a history of LBP, but without current LBP at that point were included. We excluded participants who had prior back surgery. LBP was defined as pain localized between the costal margin and the inferior gluteal folds, as depicted in a diagram, with or without lower extremity pain in the past 1 month, according to a previous report [9, 14, 15]. The area was shown diagrammatically on the questionnaire, in accordance to a previous study [9, 15]. LBP was defined as a history of medical consultation for LBP. Medical consultation for LBP is one of the standards for evaluating the severity of LBP; it indicated that the LBP was not mild [16]. In 2016, we invited the 91 volunteers to undergo a follow-up MRI. Of these, we invited 41 incumbent personnel three times via our institution's intranet. We tried sending

postal mails to the rest of the 50 retired personnel because we did not know their e-mail addresses; however, new postal addresses of 15 of these 50 were unknown. Eventually, 49 volunteers participated in the follow-up. We enquired whether they had had LBP history during the 10 years between the baseline and follow-up study, according to the aforementioned definition of LBP. However, we did not enquire whether LBP was a single episode or multiple episodes, if they had had LBP history. The participants' smoking history was also established. We then compared the demographic data of the participants who did and did not participate in the follow-up study, in order to validate that the participants in the follow-up study were representative of all the participants in the baseline study. This study was approved by the medical/ethics review board of Kanto Rosai Hospital. Informed consent was obtained from all individual participants included in the study.

Image assessment

MRI was performed using a 1.5T Siemens Symphony scanner (Siemens Healthcare, Erlangen, Germany). The imaging protocol included sagittal T1-weighted and T2-weighted fast spin echo (repetition time: 3,500 ms/echo, echo time: 120 ms, field of view: 300 × 320 mm), similar to our baseline study [9]. Sagittal T1- and T2-weighted images were used to assess the intervertebral space from T12/L1 to L5/S1. We had evaluated the intra-observer and inter-observer variability of assessment of the lumbar MRI scans in the previous study as greater than moderate for all evaluated items [9]; therefore, assessment of the follow-up MRI scans was performed by an orthopedist (J. T.), who was blinded to the participants' backgrounds. We evaluated the degree of disc degeneration, disc bulging, high-intensity zone (HIZ), spondylolisthesis, and Modic changes at each level of the spine. The degree of disc degeneration on MRI was classified into five grades, based on the Pfirrmann's classification system [17]. We divided the grading into two groups for the purpose of analysis. We regarded those with grades 1–3 as having no or little disc degeneration, and those with grades 4–5 as having some degree of disc degeneration. Disc bulging was defined as displacement of the disc material, usually by more than 50% of the disc circumference and less than 3 mm beyond the edges of the disc space in the axial plane [18]. As we were only able to evaluate the sagittal planes of the MRI scans, we defined disc bulging as posterior disc displacement less than 3 mm and equivalent to the anterior disc displacement in the sagittal plane, although we could not evaluate more than 50% of the circumference. In the midline slice of sagittal planes, the points of the inferior posterior edge of the upper vertebra and superior posterior edge of the lower vertebra were marked, the two points were connected with a line, and the distance between the top of the posterior bulging disc and the line for evaluating posterior bulging was measured. Anterior bulging was evaluated in the same way. We defined HIZ as an area of brightness or high signal intensity located in the posterior annulus on T2-weighted images, based on previous literature [19]. We defined spondylolisthesis as vertebral slips of >5 mm. Those definitions of the four findings were matched as our baseline study [9]. Modic change was divided as three types according to the definition: low intensity in T1-weighted images and high intensity in T2-weighted images was defined as Modic type 1; high intensity in both T1- and T2-weighted images as Modic type 2; and low intensity in both T1- and T2-weighted images as Modic type 3 [20]. However, in the final analysis, we only evaluated whether any type of Modic changes existed or not.

When a participant had at least one positive finding in any disc level for the item, we regarded the findings of the participant as positive as a whole. Finally, we focused on the relationship between LBP history during the 10 years and the MRI findings at follow-up, baseline, and the progress over 10 years. The progress of each finding was defined as a positive finding at follow-up MRI with negative finding at baseline MRI.

Statistical analysis

Between-group differences in baseline characteristics were evaluated using the Fisher's exact test for categorical variables and the Student's t-test for continuous variables. We compared the differences in MRI findings over 10 years between groups with and without LBP history over 10 years by using Fisher's exact test. Furthermore, we determined the odds ratios of each item using univariate analyses. Statistical analyses were performed using the JMP 11.0 software program (SAS Institute, Cary, NC, USA). A p value of <0.05 was considered to be significant.

Results

Of the 91 participants in the baseline study, 41 participants were incumbent and 50 had retired. Of the 41 incumbent participants, 31 participated in the follow-up study, while of the 50 retired participants, 18 participated in the follow-up study. Addresses of 15 retired participants were unknown; thus, we were unable to send postal mails inquiring about their participation. Eventually, of the 91 participants in the baseline study, 49 (54%) participated in the follow-up study. The reasons for no participation are shown (Table 1).

The average ages of those who did and did not participate at the follow-up study were 44.9 and 44.6 years, respectively, which was not significantly different.

There were also no significant differences in sex, bone mass index (BMI), and smoking habit at baseline between the groups (Table 2).

Of the 49 participants in the follow-up study, 36 had a history of LBP during the 10 years between the baseline and follow-up study. Participants' average age was 44.9 ± 9.3 years; 25 were female and 24 were male; and their average body mass index was 21.8 ± 4.4 kg/m^2. The average ages of those who did and did not have LBP history over the 10 years were 46.4 and 44.4 years, respectively, which was not significantly different. There were also no significant differences in sex, BMI, and smoking history between the groups (Table 3).

Compared with the group without LBP history during the 10 years, the group that did develop LBP did not have a significantly increased incidence of disc degeneration in at least one spinal level in the follow-up MRIs, compared with the baseline MRIs. There were also no

Table 1. Details of the participants of the follow-up study.

	Total: 91	Follow-up (+): 49	Follow-up (-): 42	Reason of no participation
Incumbent	41	31	10	Not intending: 5
				No reply: 5
Retired	50	18	32	Not intending: 8
				No reply: 9
				New address unknown: 15

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Table 2. Demographic data of the participants who did and did not participate in the follow-up study.

		Total: 91	Follow-up (+): 49	Follow-up (-): 42	p-value
Age		44.8 ± 10.7	44.9 ± 9.3	44.6 ± 12.3	0.8966
Sex	Female	48	25 (51.0)	23 (54.8)	0.8337
	Male	43	24 (49.0)	19 (45.2)	
BMI	(kg/m^2)	21.5 ± 3.8	21.8 ± 4.4	21.1 ± 2.7	0.4051
Smoking habit at baseline	(+)	32 (35.2)	19 (38.8)	13 (31.0)	0.5116

Data are shown as mean ± standard deviation or number of participants (%).

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Table 3. Demographic data of participants who did and did not have low back pain history during the 10 years between the baseline and follow-up study data are shown as mean ± standard deviation or number of participants (%). LBP; low back pain.

		Total: 49	LBP history: 36	No LBP history: 13	p-value
Age		44.9 ± 9.3	46.4 ± 11.0	44.4 ± 8.7	0.4968
Sex	Female	25	18 (72.0)	7 (28.0)	1.0000
	Male	24	18 (75.0)	6 (25.0)	
BMI	(kg/m^2)	21.8±4.4	21.7±5.0	22.1±2.6	0.8019
Smoking history	(+)	17 (34.7)	13 (36.1)	4 (30.8)	1.0000

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significant differences between the two groups with regards to the progress of disc degeneration over 10 years (Table 4). Additionally, no significant differences in disc bulging in the follow-up and baseline MRI were found between the two groups. Progress of disc bulging was also not significantly related to LBP history during the 10 years (Table 4). There were also no significant differences between the two groups in terms of HIZ in the follow-up and baseline MRI. Progress of HIZ was also not significantly related to LBP history during the 10 years (Table 4). Only two participants exhibited spondylolisthesis in both the follow-up and baseline MRI. There were no significant differences between the two groups in terms of spondylolisthesis in the follow-up and baseline MRI. Of the two participants with spondylolisthesis, one had LBP history during the 10 years, while the other did not. There was no case of progress of spondylolisthesis. Modic type 1 change was identified in only one participant in the follow-up MRI; six participants were found to have type 2, while none had type 3. There were no significant differences between the two groups with regards to Modic changes in the follow-up MRI. Univariate analysis revealed the odds ratios and 95% confidential intervals of each item; however, there were no significant differences in all items (Table 5).

Discussion

The follow-up study was performed 10 years after the baseline study, with a follow-up rate of 53.8%. Over half of the 91 participants of the baseline study had retired. The follow-up rate of the incumbents was high at 75.6%, while that of the retired group was low at 36.0%. Those

Table 4. Magnetic resonance imaging findings at the follow-up and baseline of patients with and without low back pain history during the 10 years between the baseline and follow-up study.

		Total: 49	LBP history: 36	No LBP history: 13	p-value
Disc degeneration					
Follow-up MRI	(+)	42 (85.7)	32 (88.9)	10 (76.9)	0.3629
Baseline MRI	(+)	25 (51.0)	19 (52.8)	6 (46.2)	0.7536
Progress	(+)	17 (34.7)	13 (36.1)	4 (30.8)	1.0000
Disc bulging					
Follow-up MRI	(+)	37 (75.5)	27 (75.0)	10 (76.9)	1.0000
Baseline MRI	(+)	30 (61.2)	21 (58.3)	9 (69.2)	0.7408
Progress	(+)	10 (20.4)	8 (22.2)	2 (15.4)	0.7095
High-intensity zone					
Follow-up MRI	(+)	22 (44.9)	15 (41.7)	7 (53.9)	0.5250
Baseline MRI	(+)	14 (28.6)	11 (30.1)	3 (23.1)	0.7308
Progress	(+)	9 (18.4)	5 (13.9)	4 (30.8)	0.2204

Data are shown as number of participants (%). Pfirrmann grade $\geq$4 is regarded as disc degeneration. LBP; low back pain, MRI; magnetic resonance imaging.

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Table 5. Associations between the follow-up magnetic resonance imaging findings and low back pain history during the 10 years according to univariate analyses.

	Odds ratio	95% confidential interval	p-value
Disc degeneration	2.4	0.42–12.78	0.3101
Disc bulging	0.9	0.17–3.77	0.8896
High-intensity zone	0.6	0.17–2.20	0.4500
Spondylolisthesis	0.3	0.01–9.11	0.4700
Modic changes (any)	0.9	0.16–6.81	0.8956

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who did not intend to participate in the follow-up study might not have adjusted their schedule because only two days could be spared for the follow-up MRI examination. In the institute of the personnel, those who retire leave their new postal address for the office. However, since 10 years had passed, the postal address could have changed once again. Therefore, we could not contact 15 retired participants. Although the follow-up rate was relatively low, the backgrounds of those who did and did not participate in the follow-up study were not significantly different; therefore, we regarded the results of the followed-up participants as representative of the baseline participants.

Both in the baseline and follow-up study, we precisely defined the region of LBP similar to that in our previous study [9], which seemed to be important for standardizing the study protocol for LBP [14,15]. Of the followed-up participants, 73.5% had a history of LBP between the baseline and follow-up study. This was relatively similar to the lifetime prevalence of LBP of approximately 83%, which was based on a population-based survey [2]. Therefore, it can be regarded that the normal population may also have LBP history over 10 years, as in the study participants. There were no significant differences in age, sex, BMI, and smoking history between the groups with or without LBP history during the 10 years. Several previous studies [21, 22] have indicated that smoking was associated with LBP; however, our results were not consistent with their findings.

Pfirrmann grading indicates the degree of disc degeneration [17]. Considering that disc degeneration progresses with advancing age [4], disc degeneration was more frequent in the follow-up MRI assessment compared to the baseline MRI assessment (85.7% vs. 51.0%). Seventeen participants who did not have disc degeneration in the baseline MRI demonstrated disc degeneration in the follow-up MRI. In fact, 76.9% of those who have had no LBP history during the 10 years showed disc degeneration. There have been many reports on the relationship between current LBP and disc degeneration [3, 4, 5], although the results have been controversial. Videman et al showed that disc height narrowing was associated with previous LBP [23], and our previous study showed that disc degeneration was associated with previous LBP [9]. Meanwhile, a systematic review showed that there were not consistent associations between MRI findings and future episodes of LBP [24]. If LBP history during the 10 years was regarded as having previous LBP, our current findings were not consistent with our previous study's findings, but with the systematic review.

Disc bulging was also more frequent in the follow-up MRI assessment, at 75.5% of all participants, compared to 61.2% in the baseline MRI assessment. Ten of those who did not have disc bulging in the baseline MRI showed disc bulging in the follow-up MRI. While some studies have shown that disc bulging was frequently observed in asymptomatic subjects, and concluded that there was no relationship between disc bulging and current LBP [25, 26], another meta-analysis study demonstrated that there is a strong relationship [5]. As for previous LBP, our previous study demonstrated a significant association between disc bulging and previous LBP [9], while Videman et al had reported no association [23]. The current results showed that

there were no relationships about LBP history during the 10 years in the prevalence of the follow-up MRI, the baseline MRI, and the progress of disc bulging, as reported previously.

There were no relationships of the LBP history among the prevalence of the follow up MRI, the baseline MRI and the progress of HIZ, although the frequency of HIZ increased with aging. Aprill and Bogduk reported a strong association between the annular high signal intensity zone and positive provocative discography finding [19], while Schellhas et al found that HIZ was associated with current LBP [27]. Dongfeng et al reported that HIZ may be a specific signal for the inflammatory reaction of a painful disc by their histological study [28]. Conversely, other studies have shown that HIZ was frequently observed in asymptomatic subjects [5, 25, 26]. A longitudinal MRI study showed that 26.6% of HIZ findings resolved and HIZ improved in 14% cases, with no statistical association between HIZ changes and changes in a patient's symptoms [29]. Our results were consistent with the reports that no association was observed.

Spondylolisthesis was considered to be one of the findings of lumbar spine instability [30]; in addition, it was assumed that those who had spondylolisthesis were inclined to have LBP [31]. However, several reports found no significant relationship between spondylolisthesis and current LBP [5, 32]. In the present study, only 2 participants were found to have spondylolisthesis during the baseline MRI assessment; the same 2 participants demonstrated spondylolisthesis during the follow-up assessment, although no progressions were noted. This suggested that no significant relationship was found between spondylolisthesis and LBP history during the 10 years in our study. However, this may be attributed to the small number of spondylolisthesis cases in our sample of participants.

Several reports have found that Modic type 1 change can indicate inflammation of endplates and be related to LBP [3, 33]. As Modic type 1 change was identified in only one case in the follow-up study, we analyzed the relationship between any Modic changes and LBP history during the 10 years. Our results showed that no significant relationship was found, which was inconsistent with previous reports [34, 35].

Brinjikji W et al. reported in their systematic review that disc degeneration, disc bulging, and Modic 1 changes were more prevalent in adults aged 50 years or younger with back pain compared with asymptomatic individuals, because the prevalence in the asymptomatic younger population was much lower [5]. Furthermore, they also demonstrated that disc degeneration, disc bulging, and annular fissure were present in high proportions of asymptomatic individuals, and that this increased with age [36]. Although the average age during the follow-up MRI in our study was 44.8 years, which could be regarded as young, our results were consistent with the systematic review results of an aged population.

There were several limitations to the current study. First, the findings of this study were limited and could not be generalized because of the small sample size. In addition, the follow-up rate was relatively low; however, we were able to demonstrate that the backgrounds of the participants who did and did not participate in the follow-up study were not significantly different. The statistical power was insufficient, however, as it exceeds 0.6 in all disc degeneration types, disc bulging, and high-intensity zones. The power of disc bulging was 0.76, which was the largest among the three. Second, we did not evaluate the Modic changes in the baseline MRI as only sagittal T2-weighted images were analyzed at that stage; therefore, although we evaluated both T1- and T2-weighted images in the follow-up MRI, we were unable to comment on any Modic changes in the baseline MRI. Third, disc bulging and HIZ can sometimes be visible from the posterolateral sides; however, as we only analyzed sagittal images, these findings may have been underestimated. In other words, there is a possibility that the pathology was missed in the zone between the planes of the posterior and anterior vertebral body cortices because only sagittal images were used. Although this limitation had been written in

our previous study [9], we also did analyze only sagittal images in the follow-up study, because we preferred same definition of those findings as same as the previous study. Fourth, there was selection bias among our study participants, as they were volunteers from all types of employment at the hospital and did not represent the general population. This was also the limitation in our previous study [9]. Lastly, the lack of specific information about frequency and severity of LBP episodes in the study cohort may be seen as a limitation of this study as well.

Conclusions

The follow-up MRI findings consistent with Pfirrmann grading $\geq$4, disc bulging, HIZ, spondylolisthesis, and any type of Modic changes were not associated with LBP history during the 10 years between the baseline and follow-up study. The progress of these findings was also not associated with the LBP history. In addition, baseline MRI findings were not associated with LBP history during the 10 years; therefore, our data suggest that baseline MRI findings cannot predict future LBP.

Supporting information

S1 File. Supporting information. Dataset set of this study.
(XLSX)

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RESEARCH ARTICLE

MRI-defined paraspinal muscle morphology in Japanese population: The Wakayama Spine Study

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Abstract

Objective

This study aimed to establish sex- and age-dependent distributions of the cross sectional area and fatty infiltration ratio of paraspinal muscles, and to examine the correlation between paraspinal muscle degeneration and low back pain in the Japanese population.

Methods

In this cross-sectional study, data from 796 participants (241 men, 555 women; mean age, 63.5 years) were analyzed. The measurement of the cross sectional area and fatty infiltration ratio of the erector spinae and multifidus from the level of T12/L1 to L4/5 and psoas major at the level of T12/L1 was performed using axial T2-weighted magnetic resonance imaging. Multivariate logistic regression analysis was used to estimate the association between fatty infiltration of the paraspinal muscles and the prevalence of low back pain.

Results

The cross sectional area was larger in men than women, and tended to decrease with age, with the exception of the erector spinae at T12/L1 and L1/2 in women. The fatty infiltration ratio was lower in men than women, except for multifidus at T12/L1 in 70–79 year-olds and psoas major in those less than 50 years-old, and tended to increase with age. Logistic regression analysis adjusted for age, sex, and body mass index showed that the fatty infiltration ratio of the erector spinae at L1/2 and L2/3 was significantly associated with low back

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pain (L1/2 level: odds ratio, 1.05; 95% confidence interval, 1.005–1.104; L2/3 level: odds ratio, 1.05; 95% confidence interval, 1.001–1.113).

Conclusion

This study measured the cross sectional area and fatty infiltration ratio of paraspinal muscles in the Japanese population using magnetic resonance imaging, and demonstrated that the fatty infiltration ratio of the erector spinae in the upper lumbar spine was significantly associated with the presence of low back pain. The measurements could be used as reference values, which are important for future comparative studies.

Introduction

Sarcopenia, which is characterized by the loss of muscle mass and strength associated with aging, is a common problem in elderly societies [1–4]. The reduction of muscle mass and physical strength leads to disability, poor quality of life, loss of independence, and mortality [5]. The prevalence of sarcopenia in the age strata of 75–79, 80–84, and ≥85 year-olds has been reported to be 17.8%, 23.2%, and 31.8% in men and 13.8%, 22.9%, and 62.2% in women, respectively [6]. Sarcopenia is common and believed to play a major role in the pathogenesis of frailty in the aging population [1,5].

Low back pain (LBP) is also a common cause of morbidity and disability [7,8]. LBP is recognized as a multifactorial symptom. There are many causes of LBP, and the influence of paraspinal muscle degeneration on LBP has attracted interest in studies investigating the pathophysiology of LBP [9]. Muscle degeneration with aging has been characterized by muscle atrophy and fatty infiltration [10–14]. Although morphologic information on muscles can be obtained by computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonic imaging techniques, MRI provides precise and reliable measurements of muscles, and can be considered the criterion standard for evaluating muscle size and structure [10–17]. Some studies reported age-related morphologic changes of the lumbar paravertebral muscles and the association between degeneration of the paraspinal muscles and LBP using MRI, but these studies included patients or volunteers, suggesting selection bias [9, 11–13]. To the best of our knowledge, no research to date has assessed age-related degeneration of paravertebral muscles in the general population.

The purpose of this study was twofold: first, to quantify age-dependent morphologic changes (muscle atrophy and fatty infiltration) of the lumbar paraspinal muscles using MRI in the Japanese population, which could be used as reference values for evaluation of the paraspinal muscles, and second, to evaluate the association between paraspinal muscle degeneration and LBP. We performed a cross-sectional, population-based study for this purpose.

Materials and methods

This study was approved by Ethics Committee of Wakayama Medical University (No.373).

Participants

The Wakayama Spine Study is a population-based study of degenerative spinal disease [18–22] performed in a sub-cohort of the large-scale, population-based cohort study Research on Osteoarthritis/Osteoporosis against Disability (ROAD) [23,24]. ROAD is a nationwide, prospective

study of bone and joint diseases consisting of population-based cohorts established in three communities in Japan. Participants were recruited from listings of resident registrations in three communities that have different characteristics: an urban region in I town, Tokyo; a mountainous region in H town, Wakayama; and a coastal region in T town, Wakayama. Inclusion criteria, apart from residing in those communities, included the ability to walk to the survey site, to report data, and to understand and sign an informed consent form. A detailed profile of the ROAD study has already been described elsewhere [23,24]. Here, we summarize the characteristics of the present study. A third visit of the ROAD study began in 2012 and was completed in 2013. From the third visit of the ROAD study, 1575 individuals (718 individuals in the mountainous region, 857 individuals in the coastal region) were recruited to the second visit of the Wakayama Spine Study. Unfortunately, fundamental limitations allowed MRI to be conducted only in the coastal area. Thus, we evaluated data from 857 individuals in the coastal area for the present study. Among them, 42 participants with incomplete MRI records, 6 participants with unsuitable MRI for evaluating the paraspinal muscles, one participant who had previously undergone posterior lumbar fusion and 12 participants with deficits based on clinical symptoms related to LBP were excluded.

Experienced board-certified orthopedic surgeons also asked all participants the following question regarding LBP: "Have you experienced LBP on most days during the past month, in addition to now?" Those who answered "yes" were defined as having LBP based on previous studies [25–29]. We could not obtain the answer from 12 participants, therefore, these participants who lacked information regarding LBP were excluded. Thus, 796 participants (241 men and 555 women) ranging in age from 19 to 93 years-old (mean, 63.1 years-old for men and 63.7 years-old for women) were included in the analysis (Fig 1). All study participants provided informed consent, and the study design was approved by the appropriate ethics review boards.

Magnetic resonance imaging

A mobile MRI unit (Achieva 1.5 T; Philips Medical Systems, Best, the Netherlands) was used, and whole-spine MRI was performed for all participants on the same day as the examination. The participants were supine during the MRI, and those with rounded backs used triangular pillows under their heads and knees. The imaging protocol included sagittal T2-weighted fast spin echo imaging (repetition time, 3,000 ms/echo; echo time, 120 ms; and field of view, 270 × 270 mm) and axial T2-weighted fast spin echo imaging (repetition time, 2,100 ms/echo; echo time, 100 ms; and field of view, 180 × 180 mm). Sagittal images were taken for the entire spine, but axial images were obtained for each lumbar intervertebral level (T12/L1-L5/S1) parallel to the vertebral endplates.

Measurement of the cross sectional area and fatty infiltration ratio of paraspinal muscles

The measurement of the cross sectional area (CSA) and fatty infiltration ratio (FI %) of paraspinal muscles (erector spinae, multifidus, and psoas major) was performed with axial T2-weighted images using a radiological workstation specially designed for such purposes. The measurement of erector spinae and multifidus was performed from the level of T12/L1 to L4/5, and that of the psoas major was performed at the level of L4/5. The CSA was measured by manually constructing polygon points around the outer margins of the individual muscles (Fig 2). The FI % was defined as the percentage of fatty infiltration area, which was obtained by dividing the fatty infiltration area by the total area. For the measurement of the fatty infiltration area, all pixels in the region of interest were sorted into three clusters based on counting

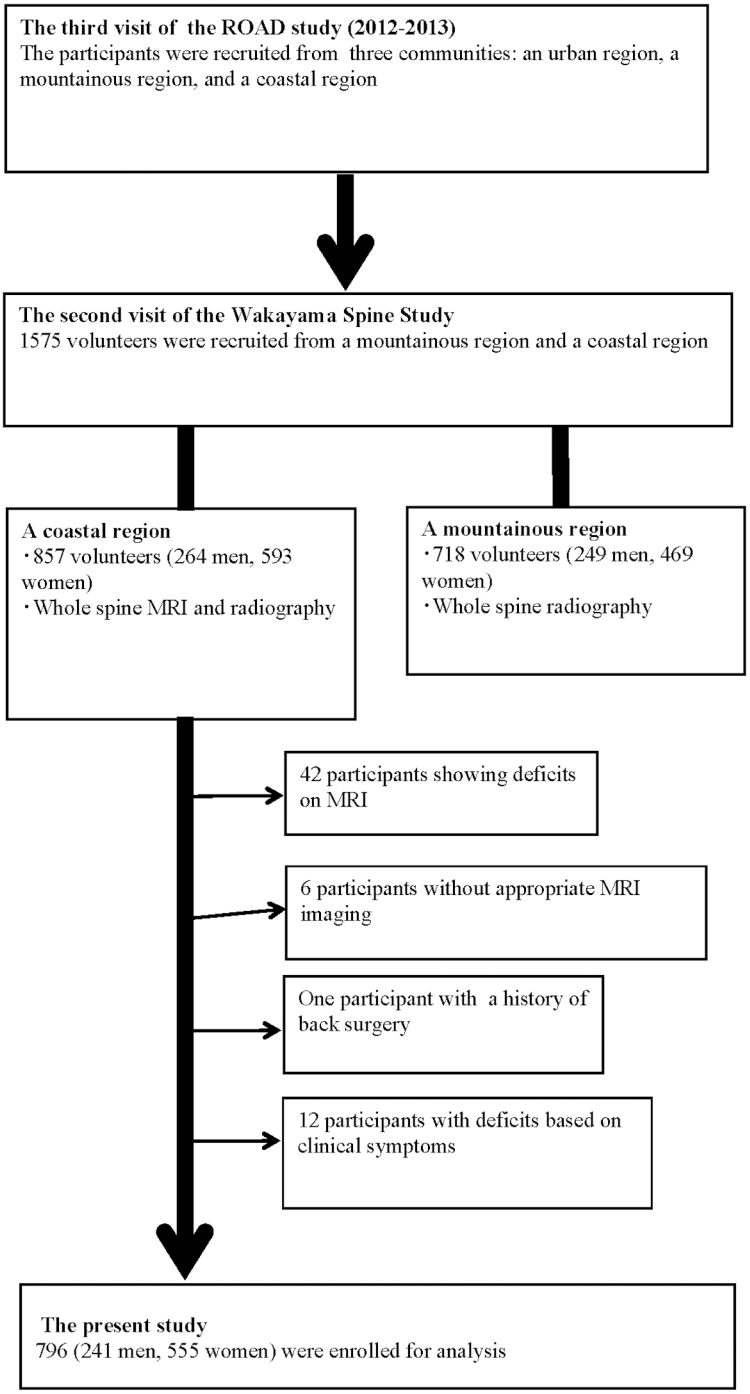

Fig 1. Flow diagram depicting participants recruited to the present study from the third visit of the ROAD study.

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pixel number and signal intensity by the k-means method [30]. That is, all pixels were distributed to low, medium, and high intensity areas. The high intensity area was defined as the fatty infiltration area (Fig 2). The CSA and FI % of paraspinal muscles were separately measured on the bilateral sides, and mean values were calculated. All measurements were taken by an orthopedic surgeon blinded to participants' background. To evaluate inter- and intraobserver

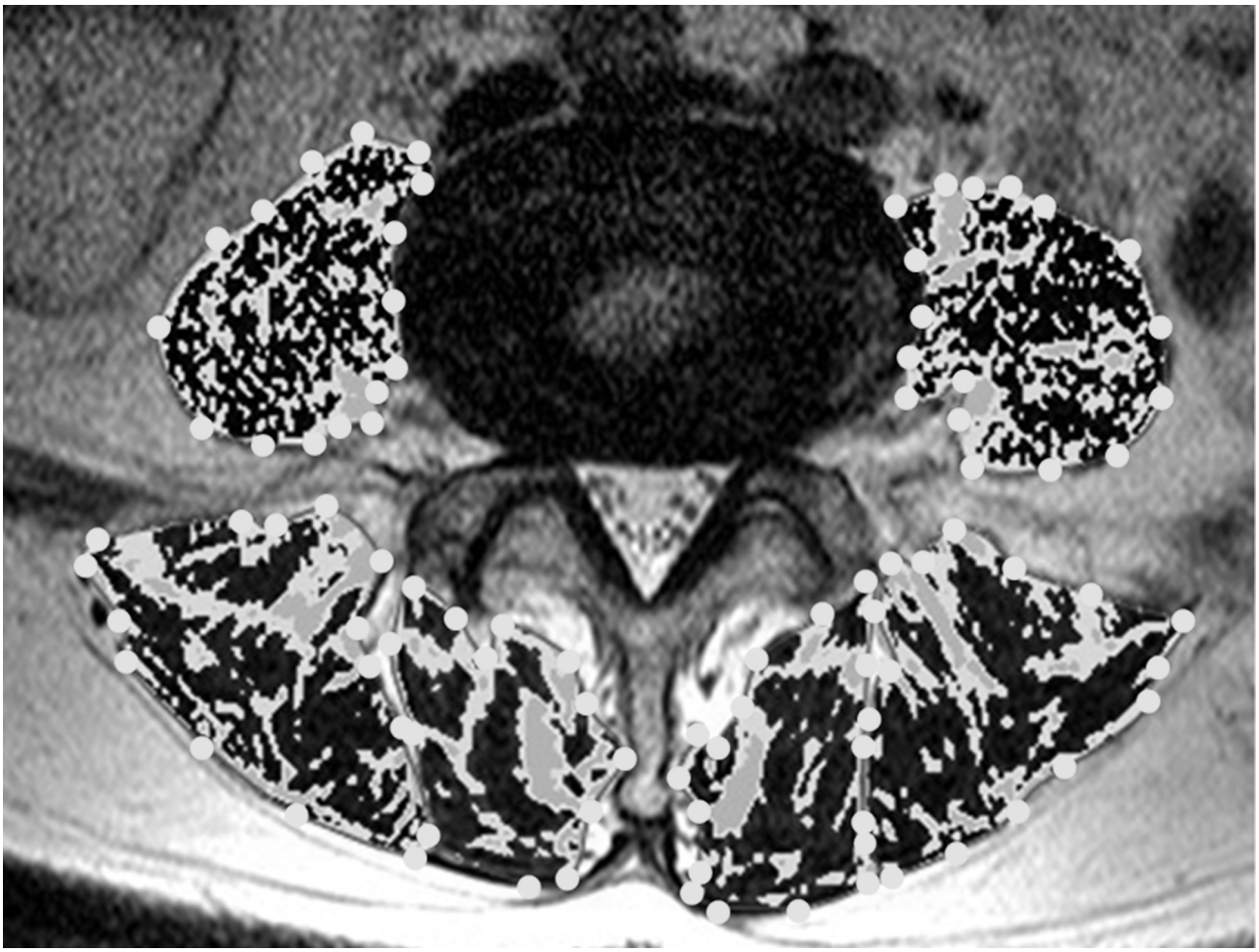

Fig 2. Measurement technique for CSA and FI % of paraspinal muscles. The region of black, blue, and red color represents low, medium, and high intensity areas, respectively. The high intensity area was defined as the fatty infiltration area. CSA, cross sectional area; FI %, fatty infiltration ratio.

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reliability for the measurement of CSA and FI %, the intraclass correlation coefficient (ICC) was calculated. To evaluate interobserver reliability, 80 randomly selected MR images were interpreted by two orthopedic surgeons (TS and HI). For evaluating intraobserver reliability, the measurements of those images were performed two times by the same observer (TS) with an interval between them greater than 1 month. All ICCs of CSA and FI % measurements were 0.99 for inter- and intraobserver reliability.

Statistical analysis

Descriptive statistics were used to summarize demographic characteristics and the distribution of CSA and FI % of the paraspinal muscles. Wilcoxon tests were used to compare values of CSA and FI % between sexes in the corresponding group. The Jonckheere-Terpstra test was used to identify trends with regard to age for CSA and FI %. The significance of differences in demographic characteristics and FI % between groups of participants with and without LBP was tested using Wilcoxon test for continuous variables and Chi-square test for categorical data. To test the association between the presence of LBP and FI %, we used multivariable logistic-regression analysis adjusted for age, sex, and body mass index (BMI). In the regression

analysis, we used the presence or absence of LBP as the objective variable, and the FI % of the erector spinae and multifidus at five disk levels (T12/L1, L1/2, L2/3, L3/4, L4/5) and psoas major at the L4/5 level, respectively, as explanatory variables, in addition to basic characteristics such as age, sex, and BMI. That is, a total of 11 models were analyzed in the multivariate logistic-regression analysis. The association between the presence of LBP and CSA was not examined because CSA was influenced by physique. All statistical analyses except the Jonckheere-Terpstra test were performed using JMP, version 12 (SAS Institute Japan, Tokyo, Japan). The Jonckheere-Terpstra test was performed using SPSS Statistics 23 (IBM Japan, Tokyo, Japan). A p-value of 0.05 was considered to indicate significant difference.

Results

Characteristics of participants

Table 1 shows the characteristics of the 796 participants in the present study, including age, demographic measurements, and LBP. The prevalence of LBP in men and women was 38.6% and 38.7%, respectively.

Distribution of CSA of paraspinal muscles

Sex- and age-dependent distributions of CSA of paraspinal muscles are shown in Table 2. According to sex, men had a significantly larger CSA in comparison to women in all muscles at all intervertebral levels and at all age strata. In terms of the effects of age on CSA, the Jonckheere-Terpstra test showed that there was a statistically significant trend towards smaller median CSAs with higher age strata in all muscles at all intervertebral levels in both genders, with the exception of the erector spinae at T12/L1 and L1/2 levels in women. The decreasing tendency of CSA of women was milder compared with that of men in all muscles at all intervertebral levels, except for multifidus at L3/4 and L4/5 levels.

Table 1. Characteristics of participants.

Men	Total	<50	50–59	60–69	70–79	≧80
Number of participants	241	39	46	78	46	32
Demographic characteristic						
Age (years)	63.1±14.1	39.8±7.3	55.3±2.7	64.3±2.5	73.7±2.8	84.5±3.5
Height (cm)	166.7±6.8	172.4±7.0	168.4±6.4	167.3±5.1	163.5±5.6	160.8±5.5
Weight (kg)	66.6±10.8	72.4±8.9	67.8±11.2	68.1±10.1	64.6±10.4	57.2±7.9
Body mass index (kg/m^2)	23.9±3.5	24.4±3.2	23.9±3.3	24.3±3.7	24.1±3.5	22.2±3.5
Clinical symptoms						
Low back pain	93 (38.6)	9 (23.1)	17 (37.0)	33 (42.3)	22 (47.8)	12 (37.5)
Women	**Total**	**<50**	**50–59**	**60–69**	**70–79**	**≧80**
Number of participants	555	72	123	163	145	52
Demographic characteristic						
Age (years)	63.7±12.8	41.2±6.7	54.5±2.9	64.8±2.9	74.3±2.9	83.2±2.7
Height (cm)	153.3±6.4	158.5±4.5	155.8±4.7	153.3±6.0	150.9±6.2	147.4±6.0
Weight (kg)	53.0±8.9	52.9±8.7	55.1±9.6	52.8±8.6	53.4±8.8	48.0±6.6
Body mass index (kg/m^2)	22.6±3.6	21.0±3.2	22.7±4.0	22.5±3.5	23.4±3.6	22.2±3.2
Clinical symptoms						
Low back pain	215 (38.7)	24 (33.3)	49 (39.8)	60 (36.8)	55 (37.9)	27 (51.9)

Data are presented as mean ± standard deviation or as n (%).

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Table 2. Distribution of CSA of paraspinal muscles (cm^2).

Erector spinae	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	16.0±3.4*	18.5±2.7*	16.6±3.1*	16.6±2.8*	15.0±3.3*	12.5±2.9‡	p < 0.0005
	L1/2	18.9±3.7*	21.6±3.1*	19.3±3.3*	19.3±3.0*	17.7±3.6*	15.6±3.4*	p < 0.0005
	L2/3	18.4±3.6*	21.3±3.3*	18.8±3.6*	18.9±3.0*	17.2±3.0*	15.2±3.1*	p < 0.0005
	L3/4	16.4±3.3*	19.5±3.2*	16.7±3.2*	16.6±2.5*	14.9±2.7*	13.7±2.7*	p < 0.0005
	L4/5	12.8±3.0*	15.7±2.8*	13.1±3.0*	12.5±2.5*	11.4±2.3§	11.3±2.9*	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	11.6±2.3	11.5±2.3	12.0±1.9	11.7±2.3	11.7±2.3	10.4±2.3	p = 0.069
	L1/2	13.4±2.5	13.4±2.7	13.8±2.2	13.3±2.5	13.5±2.5	12.0±2.3	p = 0.064
	L2/3	13.0±2.5	13.5±2.5	13.6±2.3	13.0±2.5	13.0±2.6	11.1±2.1	p < 0.0005
	L3/4	12.0±2.4	12.7±2.1	12.7±2.4	11.9±2.4	12.0±2.3	10.3±1.7	p < 0.0005
	L4/5	10.5±2.3	11.4±2.0	11.2±2.2	10.3±2.2	10.4±2.3	8.7±2.0	p < 0.0005
Multifidus	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	2.4±0.5*	2.8±0.4*	2.4±0.5*	2.4±0.5*	2.1±0.5‡	2.1±0.5‡	p < 0.0005
	L1/2	2.4±0.5*	2.7±0.5*	2.4±0.5*	2.4±0.5*	2.2±0.6*	2.0±0.4‡	p < 0.0005
	L2/3	3.3±0.9*	4.0±0.9*	3.4±0.6*	3.4±0.8*	3.1±0.8*	2.5±0.5‖	p < 0.0005
	L3/4	5.0±1.3*	5.6±1.3*	5.3±1.0*	51±1.2*	4.6±1.5*	4.0±0.9*	p < 0.0005
	L4/5	7.4±1.5*	8.0±1.3*	7.8±1.4*	7.6±1.2*	7.1±1.7*	5.9±1.2†	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	1.9±0.4	2.0±0.4	1.9±0.4	19±0.4	1.8±0.4	1.8±0.4	p = 0.001
	L1/2	1.8±0.4	2.1±0.5	1.9±0.4	1.8±0.4	1.8±0.4	1.7±0.5	p < 0.0005
	L2/3	2.5±0.6	2.9±0.7	2.7±0.6	2.5±0.6	2.3±0.6	2.2±0.5	p < 0.0005
	L3/4	3.8±0.9	4.3±0.9	4.1±0.9	3.8±0.7	3.5±0.8	3.1±0.8	p < 0.0005
	L4/5	5.7±1.3	6.5±1.4	6.1±1.1	5.7±1.1	5.2±1.3	4.7±1.5	p < 0.0005
Psoas major	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	L4/5	13.0±2.8*	15.4±2.5*	14.0±2.5*	13.1±2.4*	11.7±2.0*	9.9±1.9*	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	L4/5	8.1±1.5	8.9±1.5	8.2±1.3	8.0±1.5	8.0±1.4	7.2±1.4	p < 0.0005

Data are presented as mean ± standard deviation. CSA, cross sectional area. The men had significantly larger CSA than the women.

* p < 0.0001

† p = 0.0004

‡ p < 0.005

§ p < 0.01

|| p < 0.05 vs. women in the corresponding group by the Wilcoxon test.

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The CSAs showed a tendency to decrease with age, except for erector spinae at T12/L1 and L1/2 in women by the Jonckheere-Terpestra test.

Distribution of FI % of paraspinal muscles

Table 3 showed sex- and age-dependent distributions of FI % of paraspinal muscles. According to sex, the women had a significantly higher FI % in comparison to the men in all muscles at all intervertebral levels at all age strata, except for multifidus at the T12/L1 level in the 70–79 years-old group and the psoas major in the less than 50 years-old group. In terms of the effects of age on FI %, the Jonckheere-Terpstra test showed that there was a statistically significant trend towards higher median FI % with higher age strata in all muscles at all intervertebral levels in both genders. The increasing tendency of the FI % of men was milder compared with that of women in all muscles at all intervertebral levels, except for the erector spinae at the L4/

Table 3. Distribution of FI % of paraspinal muscles (%).

Erector spinae	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	6.4±2.8	4.8±2.0	5.3±1.1	6.0±1.8	8.3±4.4	8.1±2.6	p < 0.0005
	L1/2	6.3±2.6	5.0±2.6	5.4±1.3	5.9±1.8	8.1±3.5	7.9±2.6	p < 0.0005
	L2/3	6.2±2.5	4.4±1.6	5.3±1.3	6.3±2.0	7.7±3.0	7.9±2.6	p < 0.0005
	L3/4	7.8±2.8	5.5±2.9	6.7±1.8	7.7±2.1	9.6±2.8	10.0±2.4	p < 0.0005
	L4/5	10.1±3.9	6.5±1.7	8.2±2.0	10.1±3.5	12.4±3.7	14.0±3.1	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	8.5±4.9*	5.5±1.2†	6.6±1.8 *	7.7±3.0*	10.9±6.4†	12.7±7.3 *	p < 0.0005
	L1/2	8.2±4.2*	5.5±1.3†	6.5±1.8 *	7.6±2.7*	10.2±5.1†	12.1±6.5 *	p < 0.0005
	L2/3	8.2±3.7*	5.5±1.3*	6.8±2.1 *	7.7±2.7*	10.2±4.0*	11.7±5.1 *	p < 0.0005
	L3/4	10.3±4.0*	6.7±1.5*	8.5±2.3 *	10.2±3.2*	12.4±3.8*	14.3±5.5 *	p < 0.0005
	L4/5	12.9±4.7*	8.3±1.7*	10.7±3.2 *	12.9±3.7*	15.5±4.5*	16.9±5.4§	p < 0.0005
Multifidus	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	11.6±4.6	7.3±1.8	9.7±3.1	11.4±3.5	15.1±5.3	15.4±3.6	p < 0.0005
	L1/2	9.2±4.0	5.9±2.0	7.6±2.7	8.6±2.4	12.1±4.1	13.1±4.4	p < 0.0005
	L2/3	7.8±3.3	5.4±1.5	6.3±1.9	7.5±2.4	10.0±4.3	10.7±3.7	p < 0.0005
	L3/4	7.7±3.8	5.4±2.2	6.0±2.1	7.1±2.8	9.6±4.8	11.8±3.9	p < 0.0005
	L4/5	8.7±4.4	5.8±1.6	7.1±2.2	7.9±3.2	11.2±4.6	13.4±6.1	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	T12/L1	14.2±4.9*	9.8±3.0*	12.4±3.4*	14.1±3.8*	16.3±4.8¶	18.6±6.5‖	p < 0.0005
	L1/2	11.8±5.0*	7.6±2.2*	9.7±3.2*	11.5±3.7*	14.0±5.3‖	17.3±5.8†	p < 0.0005
	L2/3	10.6±5.3*	6.6±2.1‡	8.4±3.1*	10.0±3.6*	13.4±5.7*	15.9±7.8 *	p < 0.0005
	L3/4	11.4±5.6*	6.5±1.9†	9.1±3.3*	11.0±3.8*	13.9±5.4*	17.5±8.6 *	p < 0.0005
	L4/5	13.7±6.2*	7.9±2.2*	11.3±3.9*	13.3±4.7*	16.4±6.2*	20.9±8.5 *	p < 0.0005
Psoas major	Men	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	L4/5	8.7±3.0	8.3±4.2	8.8±3.9	8.4±2.4	8.9±2.1	9.8±2.0	p < 0.0005
	Women	Total	<50	50–59	60–69	70–79	≧80	Jonckheere-Terpstra test
	L4/5	9.9±2.7*	8.0±1.6**	9.3±2.4‖	10.2±2.6*	10.7±2.9†	10.7±2.3‖	p < 0.0005

Data are presented as mean ± standard deviation. FI %, fatty infiltration ratio. Women had a significantly higher FI % than men except for multifidus at the T12/L1 level in 70–79 year-olds and the psoas major in less than 50 year-olds.

* p < 0.0001

† p < 0.0005

‡ p < 0.001

§ p < 0.01

‖ p < 0.05

¶ p = 0.12

** p = 0.21 vs. men in the corresponding group by the Wilcoxon test.

FIs had a tendency to increase with age according to the Jonckheere-Terpestra test.

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5 level and multifidus at the T12/L1 and L1/2 levels. According to muscle, the psoas major showed the mildest tendency towards increased FI % of all three muscles at the L4/5 level in both genders.

Association of FI % of paraspinal muscles with LBP

The differences in demographic characteristics and FI % between participants with and without LBP are shown in Table 4. Concerning demographic characteristics, age was higher in the group with LBP than in the group without LBP. For the FI % of paraspinal muscles, the FI % of

Table 4. Differences in demographic characteristics and FI % between groups of participants with and without LBP.

	LBP +	LBP -	p-value
No. of participants	308	488	
Demographic characteristic			
Gender female/male	215/93	340/148	0.968
Age (years)	64.9±12.5	62.6±13.5	0.014
Height (cm)	157.5±9.3	157.3±8.8	0.857
Weight (kg)	57.7±10.9	56.8±11.6	0.238
Body mass index (kg/m^2)	23.2±3.6	22.8±3.7	0.132
FI % of erector spinae (%)			
T12/L1	8.3±5.4	7.5±3.7	0.01
L1/2	8.2±4.7	7.3±3.2	0.002
L2/3	8.1±4.1	7.3±3.0	0.003
L3/4	10.0±4.2	9.4±3.6	0.038
L4/5	12.5±4.9	11.9±4.4	0.06
FI % of multifidus (%)			
T12/L1	13.9±5.0	13.2±4.7	0.045
L1/2	11.6±5.1	10.8±4.6	0.019
L2/3	10.3±5.3	9.6±4.7	0.06
L3/4	10.8±5.5	10.0±5.3	0.043
L4/5	12.9±6.8	11.9±5.8	0.02
FI % of psoas major (%)			
L4/5	8.4±2.5	8.5±2.6	0.568

Data are presented as mean ± standard deviation or as n. LBP, low back pain; FI %, fatty infiltration ratio

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the erector spinae at T12/L1, L1/2, L2/3, and L3/4 levels and multifidus at T12/L1, L1/2, L3/4, and L4/5 levels were higher in the group with LBP ($p < 0.05$). The FI% of psoas major was not different between the LBP+ and LBP- groups.

On multivariable logistic regression analysis adjusted for sex, age, and BMI, a significant association between FI % of the erector spinae at the L1/2 and L2/3 levels and LBP was identified, as shown in Table 5 (L1/2 level: odds ratio, 1.05; 95% confidence interval, 1.005–1.104; L2/3 level: odds ratio, 1.05; 95% confidence interval, 1.001–1.113).

Discussion

We quantified CSA and FI % of the paraspinal muscles (erector spinae, multifidus, and psoas major) using MRI in 796 men and women aged 19–93 years-old, and examined the association between the presence of LBP and FI %. To the best of our knowledge, this is the first large-scale, population-based study to examine the sex- and age-dependent distributions of CSA and FI % in paraspinal muscles (erector spinae, multifidus, and psoas major). These changes may reflect the normal aging process, which is important as a reference for future comparative studies.

Little is known about normative degeneration of the lumbar paraspinal muscles, and comparisons with previous papers are limited. Only a few studies have examined age-related distributions in lumbar paraspinal muscle size, and these studies have reported inconsistent findings [11–13]. Takayama et al. investigated CSA of the paravertebral muscle using axial T2-weighted MRI in 160 patients aged 10 to 88 years-old (10 male and 10 female participants in each decade) with lumbar lordosis of more than 20˚. CSA of the paravertebral muscle was

Table 5. Association between FI % of paraspinal muscles and LBP on multivariable logistic regression analysis.

Explanatory variable	OR	95% CI	p-value
FI % of erector spinae (%)			
T12/L1	1.03	0.996–1.076	0.079
L1/2	1.05	1.005–1.104	0.03
L2/3	1.05	1.001–1.113	0.045
L3/4	1.02	0.972–1.071	0.413
L4/5	1.01	0.973–1.055	0.53
FI % of multifidus (%)			
T12/L1	1.02	0.981–1.054	0.366
L1/2	1.02	0.984–1.06	0.268
L2/3	1.01	0.977–1.05	0.488
L3/4	1.01	0.979–1.048	0.453
L4/5	1.02	0.991–1.052	0.173
FI % of psoas (%)			
L4/5	1	0.951–1.058	0.895

Data were obtained via multivariable logistic regression analysis, after adjustment for age, sex, and body mass index. FI %, fatty infiltration ratio; LBP, low back pain; OR, odds ratio; CI, confidence interval

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defined by manually tracing the fascial boundary of the multifidus and erector spinae; they reported that CSA of the paravertebral muscle tended to decrease with age [11]. In agreement with this study, our investigation showed a tendency toward decreased CSA of the paraspinal muscles (erector spinae, multifidus, and psoas major) with age. On the other hand, Crawford et al. examined the volume of the erector spinae and multifidus by 2-point Dixon 3T MRI in 80 healthy volunteers aged 20 to 62 years-old (10 male and 10 female participants in each decade, one individual per sex older than 60 years of age), and they reported that muscle volume was age-independent [12]. The discrepancy among studies may be due to methodologic differences in the measurement techniques (CSA versus volume), defined paravertebral regions of interests, and study samples.

In terms of muscle composition, a few imaging studies have analyzed fatty infiltration in the paraspinal muscles; they reported the presence of age-dependent progressive fatty infiltration [11,12,14]. Lee et al. investigated fatty infiltration of the paraspinal muscles (erector spinae, multifidus, and psoas major) using CT in 650 patients without lumbar spinal symptoms who underwent CT of the abdomen and pelvis, and reported that there was a tendency toward progressive increase in fatty infiltration of the paraspinal muscles with age [14]. Our study showed an increasing tendency of FI % of the paraspinal muscles with age; this finding agrees with the above-referenced reports.

We found an age-related decrease in CSA and increase in FI % of the paraspinal muscles in the Japanese population, suggesting progressive muscle atrophy and worsening of muscle quality as a part of the normative aging process. There are some plausible explanations behind the occurrence of muscle degeneration with aging. Immobility [31], reduced nutrition [31], denervation [32], inflammation [31,33], reduced levels of and responsiveness to growth hormone, androgens, and insulin-like growth factor I [31,34–37], increased apoptosis [31,38], impaired autophagy [31,39], and mitochondrial dysfunction [31,40] have been reported as the mechanisms of muscle degeneration. There are multiple reasons for muscle degeneration, but the pathophysiologic mechanism is poorly understood. Further investigations are warranted to clarify the mechanism for muscle degeneration with aging.

We showed that men had a larger CSA than women and women had a higher FI % than men in the paraspinal muscles. These findings agree with previous studies [11,12]. In terms of differences between sexes, it is interesting that CSA of women showed a more mild decrease with age than that of men, and FI % of men showed a more mild decrease with age compared to that of women. This finding may indicate that the degeneration of the paraspinal muscles with aging tends to occur quantitatively in men and qualitatively in women.

In the present study, different patterns of age-dependent degeneration were identified in the three muscles examined (erector spinae, multifidus, and psoas major). The psoas major showed the least fatty infiltration. This finding is similar to that of a previous study. Lee et al. reported that fatty infiltration in the psoas major was minimal, unlike the erector spinae and multifidus [14]. It could be hypothesized that the psoas major is likely unaffected by age-dependent degeneration.

Several studies reported the association between the size and fat content of the paraspinal muscles and LBP [9,41,42]. Fortin et al. reviewed studies evaluating paraspinal muscle morphology in patients with LBP and control patients, and reported that paraspinal muscles were significantly smaller in patients with chronic LBP than in control patients [9]. Teichtahl et al. investigated LBP, CSA, and fatty infiltration of the erector spinae and multifidus using MRI in 72 community-based individuals; they reported that fatty infiltration of the paraspinal muscles was associated with LBP while the CSA was not [41]. In agreement with these studies, our investigation showed an association between FI % of the erector spinae and LBP. However, only the only erector spinae was associated with LBP, and the intervertebral levels showing a correlation between FI % and LBP were only L1/2 and L2/3 on multiple logistic regression analysis, despite the presence of fatty degeneration of all three muscles at all intervertebral levels from T12/L1 to L4/5. In addition, the odds ratio was 1.05, which is not high. These findings indicate that degeneration of the paraspinal muscles does not directly cause LBP. Although the age-related degeneration of paraspinal muscles might not strongly correlate with LBP, these findings contribute to our understanding of LBP.

The present study has several limitations. First, the CSA and FI% of paraspinal muscles was measured using in-house developed software, which is not validated externally. However, the image analysis method of our software is consistent with that of previous studies. In other words, visible storage of lipids in adipocytes underneath the deep fascia of muscle, which includes the visible storage of lipids in adipocytes located between the muscle fibers and also between muscle groups, was detected as fatty infiltration of muscles [43]. Moreover, the intra-class correlation coefficient of our method was substantially high for inter- and intra-observer reliability. Thus, we believe that our image analysis method is reliable to detect the fatty infiltration of muscles. However, the smaller group of lipids stored within the muscle cells, which are known as intramyocellular lipids, could not be detected in the present study [43]. This is a major limitation of our study, and we would like to investigate this problem in a future study. Second, although more than 800 participants were included in the present analysis, the study population may not be representative of the general population because participants were recruited from only one area of Japan. Third, this is a cross-sectional study, so we could not clarify the natural history of paraspinal muscle degeneration and any causal associations between LBP and anthropometric measurements. The Wakayama Spine Study is a longitudinal survey, thus further progress will help elucidate the natural history and any causal associations. Fourth, the influence of level of physical activity was not considered. Individuals with higher activity would be expected to have less fatty infiltration. Fifth, the definition of LBP is different among many studies [29], and the observed association between paraspinal muscle degeneration and LBP might change depending on the definition. We defined LBP as "LBP present on most days during the past month, in addition to now" based on previous reports

[25–29]. Sixth, the influence of physique was not taken into account. Generally, height and body weight correlate with muscle mass. Taller individuals have longer bones and muscles and heavier individuals require more muscle mass for movement, so they would be expected to have greater muscle mass [13].

Conclusions

We measured the CSA and FI % of the paraspinal muscles (erector spinae, multifidus, and psoas major) using MRI in a Japanese population of individuals ranging in age from 19 to 93 years-old. Our study showed an age-related decrease in CSA and increase in FI % in all muscles in both genders, and that the patterns of the age-dependent degeneration were different according to gender and type of muscles. These measurements of CSA and FI % of the paraspinal muscles may be used as reference values for future comparative studies. Furthermore, our study showed a significant association between FI % of the erector spinae in the upper lumbar spine and LBP. Further investigations along with continued follow-up surveys will continue to confirm the natural history of the paraspinal muscles and their association with clinical symptoms of the lumbar spine.

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PLOS ONE

RESEARCH ARTICLE

Risk factors for incidental durotomy during posterior open spine surgery for degenerative diseases in adults: A multicenter observational study

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Abstract

Incidental durotomy (ID) is a common intraoperative complication of spine surgery. It can lead to persistent cerebrospinal fluid leakage, which may cause serious complications, including severe headache, pseudomeningocele formation, nerve root entrapment, and intracranial hemorrhage. As a result, it contributes to higher healthcare costs and poor patient outcomes. The purpose of this study was to clarify the independent risk factors that can cause ID during posterior open spine surgery for degenerative diseases in adults. We conducted a prospective multicenter study of adult patients who underwent posterior open spine surgery for degenerative diseases at 10 participating hospitals from July 2010 to June 2013. A total of 4,652 consecutive patients were enrolled. We evaluated potential risk factors, including age, sex, body mass index, American Society of Anesthesiologists physical status classification, the presence of diabetes mellitus, the use of hemodialysis, smoking status, steroid intake, location of the surgery, type of operative procedure, and past surgical history in the operated area. A multivariate logistic regression analysis was performed to identify the risk factors associated with ID. The incidence of ID was 8.2% (380/4,652). Corrective vertebral osteotomy and revision surgery were identified as independent risk factors for ID, while cervical surgery and discectomy were identified as factors that independently protected against ID during posterior open spine surgery for degenerative diseases in adults. Therefore, we identified 2 independent risk factors for and 2 protective factors

against ID. These results may contribute to making surgeons aware of the risk factors for ID and can be used to counsel patients on the risks and complications associated with open spine surgery.

Introduction

Incidental durotomy (ID) is one of the most frequent intraoperative complications of spine surgery. The reported incidence of ID ranges from 1.6% to 16% [1–9]. Although many reports have demonstrated good results after surgical repair of durotomies, serious problems secondary to durotomy have also been reported. They include severe headache, pseudomeningocele formation, nerve root entrapment, arachnoiditis, and intracranial hemorrhage [7, 10–12]. As a result, ID can contribute to higher healthcare costs and poor patient outcomes [13, 14].

Previous studies have described the risk factors for ID. They include older age [1, 3, 5–7, 9, 15], female sex [5, 6], experience level of the surgeon [9], elevated surgical invasiveness [3], lumbar surgery [3], revision surgery [1, 3, 15], pre-existing conditions such as degenerative spondylolisthesis [6, 8], ossification of the posterior longitudinal ligament (OPLL) [16], and synovial cysts [6]. However, some of these studies were performed retrospectively, at a single institution, and/or were limited by a small sample size. Even studies with a large sample size were inadequate for examining individual surgical procedures because they used a nationwide database [5, 16]. High-quality studies based on a prospective design and a large sample size are still needed.

The purpose of this study was to clarify the independent risk factors for ID during posterior open spine surgery for degenerative diseases in adults. The study used a prospectively collected multicenter data registry of more than 4,500 patients.

Materials and methods

Data source

From July 2010 to June 2013, a multicenter observational study of ID following posterior lumbar spinal surgery in adult patients was conducted in a prospective manner at 10 participating Japanese hospitals. Detailed preoperative and operative information regarding patient demographics, medical comorbidities, surgical procedures, and adverse events were recorded postoperatively through a standardized data collection form. This study was approved by the institutional review boards of Saitama Medical University, Musashino Red Cross Hospital, the University of Tokyo, Yokohama Rosai Hospital, Saitama Red Cross Hospital, Japanese Red Cross Medical Center, Tokyo Metropolitan Komagome Hospital, Sanraku Hospital, Iwai Orthopaedic Medical Hospital, and Sagamihara National Hospital. Because of the observational manner of the study, the institutional review boards of the 10 participating hospitals waived the need for consent from individuals. The opt-out information was available at the following URL (http://www.saitama-med.ac.jp/kawagoe/05others/hec/index.html). The collected patient records and information were anonymized and de-identified prior to analyses.

Patient population

Patients who underwent posterior open spine surgery for degenerative diseases were included. We excluded patients younger than 20 years of age and those who underwent endoscopic

or percutaneous surgery or open surgery for other conditions, such as infection, tumor, and trauma.

Study measures

The recorded patient characteristics included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, presence of diabetes mellitus, the use of hemodialysis, smoking status, steroid intake, location of the surgery (cervical, thoracic, and/or lumbosacral), type of operative procedure (laminectomy/laminoplasty, discectomy, posterior lumbar interbody fusion [PLIF], posterolateral fusion [PLF], and corrective vertebral osteotomy [CVO]), use of instrumentation, and past surgical history in the operated area. We defined "incidental durotomy" as an inadvertent tearing of the dura during surgery with cerebrospinal fluid (CSF) extravasation or bulging of the arachnoid layer.

Statistical analysis

We analyzed the relationship between ID and potential risk factors. The Student t-test was used to compare the means of the continuous variables between the ID and non-ID groups. For categorical values, the Pearson's chi-squared test was used to assess the differences in the proportions between the two groups. Relative risks (RRs) and 95% confidence intervals (CIs) were calculated using univariable and multivariable logistic regression analyses. All study variables that have previously been identified as significant risk factors were considered as potential confounders. We entered these variables into the multivariable logistic regression model in order to adjust for potential confounding. The variance inflation factor (VIF) was used to check for multicollinearity in the model. Statistical analysis was performed using SPSS Statistics version 20 (IBM Corporation, Armonk, NY). A *P* value of 0.05 was considered to indicate statistical significance.

Results

The demographic characteristics of the 4,652 patients included in the study are shown in Table 1.

The total incidence of ID after surgery was 8.2% (380 cases). With respect to demographic characteristics, age, female sex, lumbosacral surgery, PLIF, CVO, and revision surgery have been described as potential risk factors for ID, while smoking, cervical surgery, laminectomy or laminoplasty, and discectomy have been described as potential protective factors. These results are similar to those that we obtained with the univariable logistic regression analysis (Table 2).

Table 3 shows the results of the multivariate logistic regression analysis. When we included all of the factors in the multivariate analyses, the VIF value of laminectomy/laminoplasty was 56.6, and the VIF values of discectomy, PLIF, and PLF exceeded 10. This calculation showed multicollinearity between these factors [17]. This multicollinearity is understandable because, in this study, the meaning of "no PLIF nor PLF" and "Laminectomy/laminoplasty" were quite similar.

Therefore, we excluded laminectomy/laminoplasty from the multivariate analyses. In this model, none of the VIF values exceeded 10, indicating that there was no collinearity in the model [17] (Table 3).

The results suggested that CVO ($P = 0.02$, odds ratio [OR] = 3.17, 95% confidence interval [CI]: 1.19–7.99) and revision surgery ($P<0.0001$, OR = 2.04, 95%CI: 1.55–2.67) were independent risk factors for ID, while cervical surgery ($P = 0.0004$, OR = 0.33, 95%CI: 0.18–0.60) and discectomy ($P = 0.01$, OR = 0.55, 95% CI: 0.33–0.89) were independent protective factors against ID.

Table 1. Demographic characteristics of the ID group and Non-ID group.

Characteristic	ID group (n = 380)	Non- ID group (n = 4272)	*P* value
Age (years), mean±SD	67.7±12.5	66.0±13.5	<0.01
Male sex, n (%)	196 (51.6)	2608 (61.0)	<0.01
Body mass index (kg/m^2)	23.9±3.7	24.0±3.7	0.73
ASA score, n (%)			
1 or 2	349 (91.8)	3846 (90.0)	0.24
≥3	31 (8.2)	426 (10.0)	0.24
Diabetes mellitus, n (%)	46 (12.1)	586 (13.7)	0.35
Hemodialysis, n (%)	10 (2.6)	178 (4.2)	0.14
Smoking, n (%)	35 (9.2)	544 (12.7)	0.028
Steroid use, n (%)	6 (1.6)	109 (2.6)	0.23
Anatomic location of the surgery, n (%)			
Cervical	33 (8.7)	947 (22.2)	<0.01
Thoracic	4(1.1)	88 (2.1)	0.18
Lumbosacral	316 (83.2)	3076 (72.0)	<0.01
Operative procedure, n (%)			
Laminectomy/laminoplasty	149 (39.7)	2242 (52.5)	<0.01
Discectomy	23 (6.1)	460 (10.8)	<0.01
PLIF	165 (43.4)	1154 (27.0)	<0.01
PLF	32 (8.4)	385 (8.9)	0.70
CVO	11 (2.9)	33 (0.77)	<0.01
Surgical variables			
Instrumentation	202 (53.2)	1560 (36.5)	<0.01
Revision surgery	87 (22.9)	491 (11.5)	<0.01

ID, incidental durotomy; SD, standard deviation; ASA, American Society of Anesthesiologists; PLIF, posterior lumbar interbody fusion; PLF, posterolateral fusion; CVO, corrective vertebral osteotomy

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Discussion

In this study, we identified independent risk factors for and protective factors against ID occurring during posterior open spine surgery for degenerative diseases in adults, using a prospective multicenter research study.

Several studies have demonstrated that ID is less likely to occur during cervical surgeries than in thoracic or lumbosacral ones [4, 8]. This result is one that many surgeons can understand. In lumbosacral surgeries, surgeons are more likely to manipulate and retract the dura around the cauda equina instead of the spinal cord itself, which may lead to an increased risk of ID. In terms of anterior cervical surgery, Hannallah reported that ossification of the posterior longitudinal ligament (OPLL) caused the highest risk of ID (13.8 times) because of its adhesion to the dura [18], which are most commonly encountered in anterior approaches to the cervical spine. In this study, we only examined the posterior approach, which diminished the incidence of ID in cervical surgeries.

Discectomy, which is a relatively common and less invasive procedure, was proven to be a protective factor against ID in this study. This result is consistent with those in previous studies that showed that ID was less likely to occur in discectomy than in lumbar spinal decompression [19, 20].

Regarding CVO, this is the first study to evaluate the association between CVO and ID using a prospective multicenter design. CVO is relatively rare surgery; therefore, it is

Table 2. Univariable logistic regression analyses for ID during posterior open spine surgery.

Characteristic	OR (95% CI)	*P* value
Age	1.01 (1.00–1.02)	0.026
Female sex	1.47 (1.19–1.81)	<0.001
Body mass index	0.99 (0.97–1.02)	0.46
ASA score ≥3	0.80 (0.55–1.17)	0.26
Diabetes mellitus	0.87 (0.63–1.19)	0.38
Hemodialysis	0.62 (0.33–1.19)	0.15
Smoking	0.69 (0.49–0.99)	0.046
Steroid intake	0.61 (0.27–1.40)	0.25
Cervical surgery	0.33 (0.23–0.48)	<0.001
Thoracic surgery	0.51 (0.19–1.39)	0.19
Lumbosacral surgery	1.92 (1.46–2.54)	<0.001
Laminectomy/laminoplasty	0.58 0.47–0.72)	<0.001
Discectomy	0.53 (0.35–0.82)	0.004
PLIF	2.08 (1.68–2.57)	<0.001
PLF	0.93 (0.64–1.35)	0.7
CVO	3.83 (1.92–7.64)	<0.001
Instrumentation	1.97 (1.60–2.44)	<0.001
Revision surgery	2.28 (1.77–2.96)	<0.001

ID, incidental durotomy; OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; PLIF, posterior lumbar interbody fusion; PLF, posterolateral fusion; CVO, corrective vertebral osteotomy

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Table 3. Multivariable logistic regression analyses for ID during posterior open spine surgery.

Characteristic	OR (95% CI)	*P* value	VIF value
Age	1.00 (0.99–1.01)	0.82	1.34
Female sex	1.25 (0.998–1.57)	0.052	1.13
Body mass index	0.99 (0.97–1.01)	0.58	1.04
ASA score ≥3	0.93 (0.59–1.43)	0.76	1.38
Diabetes mellitus	0.93 (0.66–1.28)	0.65	1.03
Hemodialysis	0.63 (0.28–1.28)	0.21	1.35
Smoking	0.85 (0.58–1.23)	0.41	1.08
Steroid intake	0.52 (0.20–1.11)	0.10	1.02
Cervical surgery	0.33 (0.18–0.60)	0.0004	5.81
Thoracic surgery	0.38 (0.11–1.05)	0.06	1.52
Lumbosacral surgery	0.78 (0.49–1.28)	0.32	5.92
Discectomy	0.55 (0.33–0.89)	0.01	1.48
PLIF	1.70 (0.91–3.06)	0.09	7.59
PLF	1.05 (0.52–2.02)	0.89	3.59
CVO	3.17 (1.19–7.99)	0.02	1.40
Instrumentation	0.81 (0.46–1.50)	0.50	8.44
Revision surgery	2.04 (1.55–2.67)	<0.0001	1.07

ID, incidental durotomy; OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; PLIF, posterior lumbar interbody fusion; PLF, posterolateral fusion; CVO, corrective vertebral osteotomy

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difficult to detect this procedure as a risk factor for ID. This multicenter, large-sample study could have allowed detection of this surgery as a risk factor. CVO involves pedicle subtraction osteotomy and posterior vertebral column resection. In addition to the resection of posterior elements, these procedures also require resection of pedicles, vertebral bodies, and discs, as well as reconstruction of the spinal column with cages and pedicle screw fixation. The high surgical invasiveness and complexity of the procedure may be related to its increased risk of ID.

Many reports have described revision surgery as a significant risk factor for ID [1, 3, 15]. This result is also not altogether surprising for many surgeons. Prior surgeries can cause dural adhesions. Moreover, the absence of normal tissues attributed to prior surgeries can lead to the loss of landmarks during surgery. These atypical conditions could obfuscate anatomy and result in an increased risk of ID.

According to our multivariate analysis, women were 1.25-fold more likely than men to experience ID, and had the tendency to be an independent risk factor ($P = 0.052$, 95%CI: 0.998–1.57). Two previous reports have described female sex as a risk factor for ID [5, 6]; however, neither explained the reasons for this finding. Hong et al. analyzed dural sac thickness in the human spine and concluded that the dural sac tended to be thinner in women than in men [21]. In order to evaluate the association of female sex with ID more precisely, additional high-quality studies with a large sample size are needed.

Knowing these factors associated with increased risk of ID is very important, because they sometimes can cause large lacerations that cannot form sufficiently strong watertight seals, which can lead to severe complications. Khong et al. described a cerebellar hemorrhage caused by ID during PLIF [11]. Ryan et al. described intracranial hemorrhages following ID during pedicle subtraction osteotomy and revision arthrodesis, respectively [10]. Indeed, while repairing the dura after ID is important, being conscious of these risk factors and trying to avoid ID is even more important.

There are several limitations of this study. First, ID in this study only included durotomies detected during the surgery, and therefore did not include cases in which durotomy was speculated based on CSF leakage or severe headache after surgery. Thus, undetected durotomies might have occurred. Second, this study did not account for several factors, such as experience level of the surgeon, spondylolisthesis, or synovial cysts, which were described as risk factors for ID in some studies [9]. In addition, the occurrence of a selection bias during patient enrollment cannot be eradicated. However, we sought to minimize this bias by enrolling consecutive patients from multiple centers, not from a single center.

Conclusions

In conclusion, this prospective, multicenter study of 4,652 patients used a multivariate analysis and identified CVO and revision surgery as independent risk factors for ID, while cervical surgery and discectomy were shown to be independent factors protecting against ID during posterior open spine surgery for degenerative diseases in adults. By being aware of these risk factors, surgeons could avoid factors leading to ID during surgery. Moreover, surgeons could explain the risks and complications to patients preoperatively.

Supporting information

S1 File. Supporting information. Dataset of this study.
(XLSX)

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Author Contributions

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Original article

Information exchange using a prescribed form and involvement of occupational health nurses promotes occupational physicians to collaborate with attending physicians for supporting workers with illness in Japan

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Short running title:

COLLABORATION ON OCCUPATIONAL AND ATTENDING PHYSICIANS

Abstract

Objective: The maintenance of a balance between work and disease treatment is an important issue in Japan. This study explored factors that affect collaboration between occupational physicians (OPs) and attending physicians (APs).

Methods: A questionnaire was mailed to 1,102 OPs. The questionnaire assessed the demographic characteristics of OPs; their opinions and behaviors related to collaboration, including the exchange of medical information with APs; and the occupational health service system at their establishments.

Results: In total, 275 OPs completed the questionnaire (25.0% response rate). Over 80% of respondents believed OPs should collaborate with APs. After adjusting for company size, collaboration $\geq$10 times/year (with regard to both returning to work following sick leave and annual health check-ups for employees) was significantly associated with environmental factors, such as the presence of occupational health nurses (odds ratio (OR): 5.56 and 5.01, respectively, $p<0.05$) and the use of prescribed forms for information exchange (OR: 4.21 and 3.63, respectively, $p<0.05$) but not with the demographic characteristics of the OPs ($p>0.05$).

Conclusions: The majority of OPs believed that collaboration with APs is important for supporting workers with illnesses. Support systems including prescribed forms of information exchange and occupational health nurses, play pivotal roles in promoting this collaboration.

Key words: Occupational physicians, Occupational health nurses, Collaboration, Information exchange, Balance between work and disease treatment, Return-to-work, and Follow-up of annual health check-ups

Introduction

Recently, the maintenance of a balance between work and disease treatment has become a major social issue in Japan because of the aging labor force and low birth rate [1-5]. Collaboration between attending physicians (APs) and occupational physicians (OPs) is important for supporting workers with mental and/or physical illnesses [3-6]. In 2016, the Japanese Government and the Ministry of Health, Labour, and Welfare of Japan published guidelines for balancing work and disease treatment in the workplace [6]. According to these guidelines, collaboration between OPs and APs through employee-approved medical information exchange is important.

Such collaboration has two major goals: to ensure that treatment is accessible to employees and to allow employees to continue working despite their illness [6-11]. The former goal includes providing educational support to workers with non-communicable diseases, such as diabetes, helping them adhere to treatment recommendations, and preventing future complications [6-9]. The Clinical Guide for Diabetes issued by the Japan Diabetes Society (2016) [9] recommends collaboration between APs (diabetes specialists) and OPs. The latter goal includes supporting the return to work of patients with chronic diseases, such as cancer, mental health disorders, and stroke [3-6, 10, 11]. One of the integral roles of OPs are the assessment and management for employees' fitness for work in order to identify any difficulties resulting from diseases suffered, which could occur when workers hope to return to work [12-14]. OPs play indispensable roles in evaluating the fitness for work for specific tasks, ensuring a

77 satisfactory fitness between workers and their jobs, and enabling them to undertake their work
78 safely and effectively. In this context, exchanging information on workers' health condition is
79 essential for OPs, and collaboration between OPs and APs is one of the most important support systems for
80 employees on sick leave who want to return to work [11-18]. Information provided by APs is beneficial to
81 OPs and allows them to adjust workplace environments according to the employee's specific needs and
82 disabilities [10-15].

83 The importance of collaboration between OPs and APs has been highlighted in European countries,
84 where primary healthcare and occupational health are integrated [19-28]. In 2010, the United Kingdom
85 implemented the Statement of Fitness for Work (Fit Note) [29], which stipulates that general practitioners
86 (GPs) provide support to workers who wish to return to work following sick leave; its focus is on facilitating
87 the integration of their diseases or disabilities into their work [30-32]. Based on a survey in the United
88 Kingdom, GPs showed low levels of interest in collaboration, possibly due to a lack of knowledge or
89 confidence [31]. However, a past study from France noted that the majority of GPs had positive opinions
90 regarding collaboration [19]. Therefore, several educational workshops have been implemented to help GPs
91 achieve ideal outcomes from the Fit Note [33-36].

92 Collaboration between OPs and APs is most effective for the purpose of early returning to work as
93 well as for preventing non-communicable diseases [15-18, 37]. Several European studies explored the impact
94 of collaboration on early return to work in patients with cancer [15], mental disorders [16], and musculoskeletal

95 disorders [17, 18]. Three randomized control trials (RCTs) on mental disorders and orthopedic diseases
96 demonstrated the effectiveness of collaboration for shortening the illness-related absence period [16-18].
97 However, one RCT evaluating female cancers did not show a significant benefit, which may be explained by
98 the small sample size [15]. From the perspectives from an article in Japan, multifaceted interventions
99 including collaboration improved adherence to diabetes treatment recommendations [37]. Based on these
100 results, collaboration between OPs and APs is highly recommended in the Clinical Guide for Diabetes
101 formulated by the Japan Diabetes Society (2016) [9]. However, several studies have shown that current
102 models of collaboration are not effective and require improvement [19, 20, 38-41]. Specific barriers may
103 explain this ineffectiveness; for example, APs may have a poor understanding of OP roles, or support
104 measures may be insufficient for APs and OPs [5, 19, 39, 40]. Support systems for APs, including an
105 educational introduction to Fit Note and access to medical social workers, are known to promote
106 collaborative behavior [5, 34, 36, 39, 40, 42]. However, although a past report showed that occupational health
107 nurses play a supportive role for OPs with respect to health promotion activities at Japanese worksites, it
108 remains unclear whether similar support systems facilitate collaborative behavior by OPs [43]. Based on
109 these studies, we formulated the following hypotheses. First, collaborative attitudes on the parts of OPs
110 may be associated with supportive measures, such as the involvement of occupational health nurses and
111 information exchange. Second, these measures may be independent of the size of worksites or the
112 demographic characteristics of the OPs.

The primary objective of this cross-sectional study was to determine how support systems and other factors affect OP collaborative behavior toward APs. Additionally, we explored whether guidelines, which may be also useful at small worksites, promoted communication and encouraged collaboration between APs and OPs. Therefore, the aims of this study is to identify factors that may affect collaboration between OPs and APs.

Subjects and Methods

Data Collection

An anonymous questionnaire was mailed to 1,102 all the members of the Expert Community of Occupational Health Physicians of the Japan Society for Occupational Health in November 2015. This society is the largest academic organization of occupational medicine in Japan and the members of its expert community of occupational health physicians are professionals including full-time occupational physicians, part-time occupational physicians whose specialty is occupational medicine, and occupational medicine researchers working as part-time occupational physicians. Therefore, this cohort depicts the opinions and behavior of professional occupational physicians in Japan. The questionnaire focused on opinions and

behaviors related to collaboration, including the exchange of medical information, between OPs and APs as well as on corporate occupational health service systems.

Questions addressed the demographic characteristic of OPs, and eight items solicited their opinions toward collaboration with APs (see Table 2) in the service of supporting employees' return to work following sick leave, preventing diseases, and facilitating collaboration. Each question relied on a four-point Likert scale consisting of 'strongly agree,' 'agree,' 'disagree,' and 'strongly disagree.'

The questionnaire also addressed the OPs' workplaces and support measures (see Table 3), including company size, the presence of occupational health nurses, and the circumstances under which companies require OPs to collaborate with APs. Furthermore, in order to evaluate the behaviour of collaboration with APs, the frequencies of collaboration was examined under the situation of their return-to-work and of examining their annual health check-ups. Collaboration and/or medical information exchange was defined as the exchange of documents or face-to-face/telephone communication about various topics, including employees' medical conditions, medications, and plans for treatment or return to work. Since many OPs, especially part-time OPs may work for several companies at the same time in Japan, we instructed respondents of the questionnaire to select one specific workplace at their wills and answer all the other questions in the same specific workplace such as the presence of occupational health nurses or prescribed forms for collaboration. Based on this instruction, respondents of this questionnaire answered actual collaborative times of information exchange with employees' APs per year, which enabled us to analyze

collaborative behavior and its related supportive factors precisely. The Research Ethics Committee for the Faculty of Medicine at Juntendo University approved this study (No.2015076). All the participants of this study were informed and consent on documents to the purposes of the research.

Statistical Data analysis

To examine the factors affecting the annual frequency of collaboration between OPs and APs, answers submitted by retired OPs were excluded from the statistical analyses (Table3 and 4). We divided respondents into two groups according to the presence or absence of several factors and compared the difference in the frequency of collaboration between the two groups using a t-test. Logistic regression analysis was also used to calculate the odds ratios (ORs) with confidence intervals (CIs) for collaboration with APs more than or equal to 10 times per year. We set the cutoff value as 10 because the average and standard deviation of the distribution of collaboration times a year in returning-to-work was 9.2 and 10.1 respectively, and in health check-ups they were 12.5 and 11.7 respectively. In this analysis, the values of the odds ratios were adjusted for company size, and the data were converted into a binomial format depending on the number of employees (>500 employees = 1 and <500 = 0). Our rationale for this approach was that larger companies, with more than 1,000 workers, generally have occupational health support due to legal requirement in Japan (34, 35), which may be a confounding factor. From our database, the percentages of the presence of occupational health nurses in small and large sized companies

were 48.9 % and 95.6 % respectively if the cutoff value was 500, while they were 63.4 % and 96.6% respectively if the cutoff value was 1,000. Therefore, we set the cutoff value was to be 500 in order to highlight the influence by the difference of presence or absence of supportive system. OP experience was converted into a binomial value (>10 years = 1 and <10 years = 0). As for opinions about collaboration, answers as 'strongly agree' were compared to other answers in order to contrast OPs ideas more clearly. Analyses were performed IBM SPSS Statistics 22.

Results

In total, 275 OPs completed the questionnaire (response rate of 25.0%). Table 1 presents participants' characteristics about their personal and professional information. Males accounted for three-quarters of the respondents. The most common length of experience for medical physicians was 21–30 years, followed by > 30 years. The length of experience among OPs was most commonly ≤ 10 years, followed by 11–20 years. Approximately 60% of respondents were Occupational Health Physicians certified by Japan Society for Occupational Health. Additionally, approximately 55% of respondents were certified as Occupational Health Consultants through the Ministry of Health, Labour, and Welfare of Japan, while approximately 30% of respondents lacked either certification. The questionnaire revealed that 48% of participants were certified as Clinical Medicine specialists (Internal Medicine, 25.5%; Surgery, 11.6%), whereas 54% of

participants were not. Additionally, we found that the OP respondents predominantly worked part-time; this was followed by those who worked full-time or were retired.

Table 2 shows the responses from 275 OPs regarding collaboration with APs to support and enable employees to maintain a balance between work and disease treatment. The majority of OPs had affirmative opinions regarding the necessity and value of collaboration with APs in several situations, including the return to work following sick leave and the prevention of disease exacerbation. Furthermore, approximately 90% of respondents had positive views about the importance of occupational health nurses and other occupational health staff members and valued the development of strong relationships with APs. Most respondents believed that APs would be more likely to collaborate with OPs if the National Health Care Service Systems provided compensation.

To increase our understanding of the dynamics of collaboration between OPs and APs, the number of collaborations per year and affecting several factors were analyzed as shown in Table 3. This enabled us to compare the tendency of collaboration behavior between different groups of OPs. We hypothesized that collaboration was influenced by the individual backgrounds of OPs, such as their length of experience as an OP and whether they had a specialization in Occupational or Clinical Medicine. However, the specific demographic characteristics of the OPs were not associated with the frequency of collaboration. Respondents who strongly agreed with the importance of collaboration between APs and OPs regarding workers returning to work following leave for mental health disorders and with the usefulness

of collaboration to prevent exacerbation of diseases collaborated more frequently. On the other hand, strongly positive opinions regarding the importance of collaboration about individuals returning to work following a physical disease and the usefulness of collaboration for improving the effectiveness of treatment were not associated with collaboration frequency. Additionally, most support measures for OPs at companies were significantly associated with the frequency of collaboration. These support measures included the size of the company, the involvement of occupational health nurses, and the presence of specific prescribed forms for collaborating in cases of employees returning to work following sick leave and preventing disease exacerbation. However, we found that company-mandated AP–OP collaboration did not result in more collaboration than that did the absence of such mandates.

In order to adjust for company size, which can be a confounding factor against collaboration frequency, we used a logistic regression model. Table 4 shows the adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for collaborating (i.e., information exchange) at least 10 times per year about employees returning to work following sick leave and about annual health check-ups. We observed a significant relationship between the frequency of collaboration between OPs and APs and the former's positive opinions about the importance of collaboration for employees returning to work with mental health disorders and/or physical diseases (OR: 2.43, 95% CI: 1.19–4.95; OR: 2.23, 95% CI: 1.21–4.12, respectively). In terms of collaboration about annual health check-ups, there were also significant associations between the frequency of collaboration and the OPs' positive opinions regarding the importance

220 of collaboration to prevent disease exacerbation and to establish a good relationship with APs (OR, 2.04,
221 95% CI: 1.14–3.65; OR, 1.89, 95% CI: 1.06–3.36, respectively). Surprisingly, several environmental
222 factors (e.g., support for OPs) had a stronger effect on collaboration than did the factors discussed
223 previously. Collaboration related to returning to work was significantly associated with the presence of
224 occupational health nurses and the presence of prescribed forms for collaboration about returning to work
225 (OR: 5.56, 95% CI: 1.20–25.8; OR: 4.24, 95% CI: 2.01–8.82, respectively). Collaboration during annual
226 health check-ups was also significantly related to the presence of occupational health nurses and the presence
227 of prescribed forms for collaboration to support disease prevention or exacerbation (OR: 5.01, 95% CI: 1.37–
228 18.3; OR: 3.63, 95% CI: 1.94–6.79, respectively). By contrast, other factors (e.g., the backgrounds of OPs)
229 were not associated with collaboration. As shown above, environmental factors, such as the involvement
230 of occupational health nurses and guidelines including prescribed forms for collaboration, exerted significant
231 effects that were independent of those exerted by company size.
232
233 **Discussion**.
234 This is the first report showing that support measures for OPs, such as guidelines including prescribed forms
235 for information exchange and the involvement of occupational health nurses, play important roles in
236 fostering collaboration with APs. More importantly, these measures increased the frequency of
237 collaboration regardless of company size as illustrated in Table 4. These support measures were effective

238 in situations such those involving employees returning to work and follow-up of annual health check-ups.
239 Furthermore, collaboration frequency was more strongly affected by these factors than by the opinions of
240 OPs and APs. The individual demographic characteristics of OPs, including their experience and specialty,
241 were not associated with collaboration frequency. As for the measurement of collaboration frequencies,
242 data in Table 3 were strongly influenced by working hours as OPs because we did not adjust them. It is
243 true that most items regarding environmental factors shown in category III in Table 3 were influenced by
244 working hours as OPs, working type as OPs (full-time or part-time), and company size. On the other hand,
245 most items about OPs' individual background as category I and opinions about collaboration as category II
246 in Table 3 were not associated with these factors since there were no difference in distribution of working
247 hours, working type, and company size between two groups of respondents of Yes or No for corresponding
248 items. In order to standardize of this confounding factor, we adjusted company size when we calculate the
249 adjusted odds ratio in Table 4. One of the main purposes of this research is identifying factors which are
250 determinant for promoting collaboration especially in small sized companies. Therefore, we adjusted
251 company size, which has positive relationship with working hours as OPs, and this enabled us to evaluate
252 frequencies of collaboration without this confounding factor. Our findings suggest that the establishment
253 of a supportive company environment for OPs is the most effective approach to encouraging OPs to
254 collaborate with APs.

As shown in Table 2, more than 70% of OPs strongly agreed that collaboration with APs is a necessity; this was viewed as particularly important for employees returning to work following sick leave for mental health disorders and for preparing for medical emergencies. These data may be explained by the implementation of the Japanese Government's Health Care Policy in 2009, which strongly recommends collaboration between OPs and APs as well as the establishment of rehabilitation institutions to support the return of employees with mental health disorders to work. We found that more than 50% of respondents strongly believed that cooperation between OPs and APs is important for supporting the return to work of employees with chronic physical diseases who are receiving treatment as well as for preventing the exacerbation of diseases following health check-ups. Although most OPs recognized the value of collaboration with APs, the frequency of collaboration differed depending on the OP's personal characteristics. While the OP's individual background (e.g., years of experience and specialty) was not associated with the frequency of collaboration, both strongly positive opinions toward collaboration and a supportive corporate environment were significantly associated with collaboration, as shown in Table 3 and Table 4. These results suggest that a positive opinion of collaboration is associated with promoting collaboration between OPs and APs, supporting employees with mental health disorders returning to work, and trying to prevent disease exacerbation following annual health check-ups. These findings are in agreement with several other reports showing that educational interventions were effective in promoting collaborative behaviors among physicians [5, 34, 36, 39, 40, 42]. These collaboration between occupational

and clinical medicine comprises cooperation between OPs and other categories of physicians such as specialists, general practitioners, and rehabilitation clinicians [5, 11, 23-28]. Generally, larger companies have more advanced benefit programs and better systems of occupational healthcare [43, 44]. In order to accurately evaluate the effect of support measures on collaboration, adjustments for company size were performed using a logistic regression model. These analyses showed that the presence of occupational health nurses and guidelines for collaboration including prescribed forms of information exchange were significantly associated with the frequency of collaboration, even after adjusting for company size, as shown in Table 4. Considering that the adjusted odds ratios (aORs) for support measures were greater than those for highly positive opinions on collaboration, communication facilitation tools, which can be used by OPs to communicate with APs, may be more effective than educational tools for promoting the exchange of information. These results highlight the importance of implementing support measures in the occupational health system. Furthermore, when we adjusted for confounding factors in addition to company size, such as the presence of occupational health nurses and guidelines on collaboration, using multiple logistic regression analysis, we found that the adjusted odds ratios (aORs) for the presence of occupational health nurses and guidelines including prescribed forms with regard to collaboration for the purpose of supporting a return to work were 4.4 (95% CI: 1.0–21) and 3.9 (95% C.I: 1.9–8.2), respectively. Similarly, the adjusted odds ratios (aORs) for following up on annual health check-ups were 3.5 (0.9–13) and 3.3 (1.7–6.1), respectively. The association between the presence of occupational health nurses and health promotion

activities at worksites was suggested in a report from Japan [43]. From the viewpoint of collaboration between workplaces and medical institutions, occupational health nurses play an important role in the cooperative behavior of OPs with APs. From our analysis, occupational health nurses arrange the collaboration such as preparing for information exchange letters or sometimes they accompany employees' visits to APs with letters from OPs, and perhaps write up forms to APs on behalf of OPs (data not shown). These roles of occupational health nurses may be effective in cooperation between OPs and several types of physicians such as specialists and general practitioners in medical institutions or rehabilitation institutions [5, 11, 23-28]. As for the presence of prescribed forms of collaboration, it definitely reduces the burden for OPs to write up documents to APs and promote the collaboration behavior. From the facts and considerations above, both occupational health nurses and prescribed forms on collaboration were independent factors associated with increased OP–AP collaboration.

It is important for OPs to obtain medical information directly from APs to plan for an employee's return to work and to refer employees to APs (specialists) to prevent disease exacerbation. However, the workload of OPs has increased, partly due to the introduction of the obligatory Brief Job Stress Questionnaire check-ups in Japan. Therefore, efficient and convenient support systems for the exchange of medical information between OPs and APs are required. In our survey, 85.9% of large companies with at least 200 employees had support systems for employees returning to work, whereas only 64.6% of smaller companies with fewer than 200 employees had such support systems available. There may be several

barriers to the implementation of new occupational health support systems, such as hiring occupational health nurses, which is especially challenging for small companies due to the high costs. On the other hand, the implementation of guidelines including prescribed forms on information exchange is a promising approach to the promotion of collaboration in view of its low cost.

Supervisors must understand employees' health conditions to facilitate the ability of the latter to balance work and disease treatment [5]. Although the exchange of medical information between OPs and APs is useful for employees, some employees may not want anyone to have access to their health information. Therefore, the guidelines published by the Japanese Government [6] emphasize that employee agreement is always required for APs and OPs to exchange medical information. Explicit consent (e.g., a signature on documents outlining information exchange) may remove barriers to medical staffs (including APs) who have their activities restricted by confidentiality issues. Additionally, as of 2017, the government healthcare insurance system in Japan does not provide payment to APs for preparing such documents as a Fit Note. Based on our pilot survey of 282 APs who were members of the Tokyo Medical Association, the average ideal rewards for preparing a document (e.g., a Fit Note) was 3,475 yen (data not shown here, prepared for submitting another articles). The provision of appropriate rewards to APs for information exchange could improve the collaborative environment.

The number of cancer survivors is increasing in Japan, and it is important to provide support for these individuals in both workplaces and medical institutions. In medical institutions, the development of

positive attitudes and behaviors by APs (oncologists) in relation to collaborating with patients' workplace depended on the availability of support measures [5], which was consistent with our results regarding OPs in the workplace. In Japan, the length of the approved sick leave of most employees depends on the company, but most companies guarantee at least 3 to 6 months if they are regular employment, after which more than half of patients with gastric, colon, and genital cancers who want to continue their job can return to the workplace [3]. For the support of returning-to-work of contractual employment workers, we propose that legal requirement be necessary for the guarantee of the same period sickness absence, which enables OPs to take advantage of support system for collaboration. Based on our results, guidelines including prepared fixed documents are definitely useful for employees who are returning to work with these cancers [11]. Support measures and collaboration (including with rehabilitation institutions) are also required for stroke survivors [4]. Moreover, OPs can function as generalists in the workplace, as some physical diseases (e.g., chronic musculoskeletal disorders), including mental disorders [45, 46], are strongly associated with psychosocial factors, and cancer survivors often experience mental health issues, such as sleep disorders [47-49]. Supportive measures for OPs, such as guidelines including prescribed documents on collaboration, are required to enable them to care for employees with physical and mental disabilities.

This study has several limitations. First, as this was a cross-sectional study, causal associations could not be determined. Second, respondents may have provided socially desirable opinions. Thus, our responses may reflect a bias toward social desirability. Third, OPs with positive opinions on collaboration

345 may have been more likely to participate in this study. Thus, it is possible that our results overestimate the
346 awareness and frequency of collaboration. However, the factors affecting collaboration were not affected
347 by these biases.
348
349 **Conclusion**.
350 Although the majority of OPs agreed on the importance of collaboration with employees and APs, the
351 frequency of collaboration varied depending on the supportive measures within the company but not on the
352 individual characteristics of OPs. The presence of support measures, such as occupational health nurses
353 and guidelines including prescribed forms on information exchange and collaboration, plays an important
354 role in fostering a collaborative environment.
355
356
357
358 **Authors' contributions**
359 G.M. and R.I.N. planned the research for this study, collected information from previous studies, performed
360 statistical analysis, and drafted the manuscript. M.E. was consulted on the questionnaire items. M.S.
361 arranged the study area and was involved in the recruitment of study participants. Y.O. and F.K. advised

362 on data collection, statistical analysis and reviewed the manuscript. K.Y. supervised and provided advice

363 about this study. All authors read and approved the final manuscript.

364

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371

372 **Conflict of interest statement**

373 None declared.

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Table 1 Characteristics of 275 occupational physicians.

	n (%)
Gender	
Male	208 (75.6)
Female	67 (24.4)
Experience as a medical doctor (years)	
≦10	29 (10.7)
11-20	71 (26.1)
21-30	92 (33.8)
>30	80 (29.4)
Experience as an occupational physician (years)	
≦10	119 (43.5)
11-20	89 (32.5)
21-30	53 (19.3)
>30	13 (4.7)
Certification of specialist in occupational medicine	
Senior Occupational Health Physician certified by Japan Society for Occupational Health	77 (28.0)
Occupational Health Physician certified by Japan Society for Occupational Health	93 (33.8)
Occupational Health Consultant certified by Ministry of Health, Labour, and Welfare of Japan	150 (54.5)
None	85 (30.9)
Certification of specialist in clinical medicine	
Internal medicine	70 (25.5)
Surgery	32 (11.6)
Others	30 (10.9)
None	147 (53.5)
Working types as occupational physician	
Full-time	105 (38.2)
Part-time	150 (54.5)
Retired	25 (9.1)

Table 2 Opinions of 275 occupational physicians (OPs) for collaboration with attending physicians (APs) to support employees for balancing work and disease treatment: Number (%)

Items	Strongly agree	Agree	Disagree	Strongly disagree	No answers
(i) OPs should collaborate with employees' APs for supporting their return-to-work after sick leave due to mental disorders.	204 (74.2)	58 (21.1)	10 (3.6)	1 (0.4)	2
(ii) OPs should collaborate with employees' APs for supporting their return-to-work after sick leave due to chronic physical diseases.	163 (59.3)	96 (34.9)	15 (5.5)	0 (0.0)	1
(iii) OPs should collaborate with employees' APs with regard to the support of prevention of their diseases exacerbation.	146 (53.1)	114 (41.5)	13 (4.7)	1 (0.4)	1
(iv) OPs should collaborate with employees' APs with regard to support and preparation for their sudden attacks of diseases in case of emergency.	200 (72.7)	68 (24.7)	6 (2.2)	0 (0.0)	1
(v) OPs should share drug information of employees with their APs toward improving effectiveness of treating chronic diseases.	124 (45.1)	116 (42.2)	30 (10.9)	4 (1.5)	1
(vi) Occupational nurses and other staffs play important roles when OPs want to collaborate with employees' APs.	160 (58.2)	92 (33.5)	20 (7.3)	2 (0.7)	1
(vii) It is important for OPs to know several physicians at medical institutions around OPs' companies and to build good relationships with them in advance.	133 (48.4)	110 (40.0)	26 (9.5)	4 (1.5)	2
(viii) Providing compensation to APs for collaboration with OPs of patients' workplaces by national health care service system would promote this development.	94 (34.2)	100 (36.4)	68 (24.7)	11 (4.0)	2

Table 3 Factors affecting 250 occupational physicians'(OPs') times of collaboration per year by information exchange with attending physicians (APs).

Factors	Times of collaboration per year after examining employees' health check-up report[a]		t-test	Times of collaboration per year when employees' returning-to-work[a]		t-test
	Yes[b] (n[c])	No[b] (n[c])	P-value	Yes[b] (n[c])	No[b] (n[c])	P-value
I Individual background						
Experiences as OPs for more than 10 years	9.28 ± 8.9 (145)	11.58 ± 9.7 (95)	0.066	8.16 ± 7.7 (147)	8.48 ± 8.2 (97)	0.756
Certification of Occupational Health Consultant by Japanese Ministry of Health, Labour and Welfare	10.29 ± 9.2 (140)	11.04 ± 9.8 (67)	0.589	8.96 ± 8.1 (140)	7.63 ± 8.1 (70)	0.259
Certification of Occupational Health Physician by Japan Society for Occupational Health	10.76 ± 9.1 (156)	11.04 ± 9.8 (67)	0.841	9.22 ± 7.5 (156)	7.63 ± 8.1 (70)	0.150
Certification in clinical medicine	10.43 ± 9.6 (117)	10.06 ± 9.0 (129)	0.759	7.92 ± 7.9 (119)	8.65 ± 7.8 (130)	0.469
II Opinions about collaboration with APs						
OPs should collaborate with APs on employees' returning-to-work with mental disorders	10.73 ± 9.4 (176)	8.88 ± 9.0 (65)	0.170	9.01 ± 8.1 (177)	6.57 ± 7.1 (67)	0.030
OPs should collaborate with APs on employees' returning-to-work with chronic physical diseases	10.87 ± 9.6 (138)	9.38 ± 9.0 (103)	0.215	9.15 ± 8.4 (138)	7.37 ± 7.3 (106)	0.083
Collaboration with APs is valuable for OPs to support the prevention of employees' diseases exacerbation	11.53 ± 9.6 (129)	8.73 ± 8.8 (112)	0.019	8.64 ± 8.2 (129)	8.00 ± 7.6 (115)	0.525

	Sharing drug information of employee with APs is valuable for OPs to improve the effectiveness of treating chronic diseases.	10.19 ± 9.4 (108)	10.23 ± 9.3 (133)	0.968	8.15 ± 8.0 (111)	8.50 ± 7.8 (133)	0.735
III	Environmental factors of companies occupational physicians belong to						
	The number of employees is more than 1000	14.13 ± 9.3 (114)	6.70 ± 7.8 (128)	<0.001	11.17 ± 8.4 (116)	5.75 ± 6.4 (129)	<0.001
	The number of employees is more than 200	11.77 ± 9.4 (197)	3.36 ± 4.6 (45)	<0.001	9.72 ± 8.0 (200)	2.11 ± 2.6 (45)	<0.001
	OPs usually collaborate with employee's AP when his/her employer or supervisor proposes OPs to do so	9.74 ± 9.2 (124)	10.69 ± 9.5 (118)	0.431	8.31 ± 7.7 (124)	8.32 ± 8.1 (121)	0.994
	It is always required for OPs to write up a document on judging and support plan about employee's returning-to-work	10.49 ± 9.3 (200)	8.86 ± 9.1 (42)	0.304	8.80 ± 7.7 (201)	6.11 ± 8.2 (44)	0.040
	There are occupational nurses	11.85 ± 9.4 (193)	3.69 ± 5.5 (49)	<0.001	9.60 ± 8.1 (196)	3.18 ± 4.1 (49)	<0.001
	There are prescribed forms on collaborating with APs in case of employee's returning-to-work	12.45 ± 9.4 (138)	7.22 ± 8.4 (104)	<0.001	11.06 ± 8.1 (142)	4.53 ± 5.6 (103)	<0.001
	There are prescribed forms on collaborating with (referring to) APs in case of supporting the prevention of employees' diseases exacerbation	13.45 ± 9.4 (135)	6.10 ± 7.3 (107)	<0.001	10.31 ± 8.2 (136)	5.83 ± 6.6 (109)	<0.001

a: Average ± SD

b: Yes/No means whether the respondents match or agree the corresponding items.

c: The number of respondents. Total numbers of respondents are less than 250 because of no responses.

Table 4 Adjusted odds ratios (ORs) with 95% confidence intervals (CI) for collaboration (information exchange) with attending physicians (APs) ≧10 times/year among 250 occupational physicians (OPs) analyzed by logistic regression model.

	Returning-to-work	Follow-up of annual health check-ups
	ORs (95% CI)	ORs (95% CI)
I Individual background		
OPs are male	1.27 (0.65-2.51)	0.88 (0.50-1.67)
Experiences as OPs for ≧10 years	0.83 (0.46-1.51)	1.60 (0.90-2.84)
Certification of Occupational Health Consultant by Japanese Ministry of Health, Labour and Welfare	1.65 (0.90-3.00)	0.88 (0.49-1.55)
Certification in clinical medicine	0.72 (0.40-1.31)	1.11 (0.63-1.95)
II Opinions about collaboration with APs		
OPs should collaborate with APs on employees' returning-to-work with mental disorders	2.43 (1.19-4.95)	1.78 (0.93-3.41)
OPs should collaborate with APs on employees' returning-to-work with chronic physical diseases	2.23 (1.21-4.12)	1.58 (0.88-2.82)
Collaboration with APs is valuable for OPs to support the prevention of employees' diseases exacerbation	1.47 (0.82-2.66)	2.04 (1.14-3.65)
Sharing drug information of employee with APs is valuable for OPs to improve the effectiveness of treating chronic diseases.	0.82 (0.45-1.47)	1.00 (0.57-1.77)
It is important for OPs to know several physicians at medical institutions around OPs' companies and to build good relationships with them in advance.	1.71 (0.95-3.09)	1.90 (1.06-3.36)
Providing compensation to APs for collaboration with OPs of patients' workplaces by national health care service system would promote this development.	0.65 (0.35-1.22)	0.94 (0.52-1.71)

III Environment of companies where OPs are working		
It is always required for OPs to write up a document on judging and support plan about employee's returning-to-work	1.04 (0.46-2.39)	0.65 (0.29-1.45)
OPs usually collaborate with employee's AP when his/her employer or supervisor proposes OPs to do so	0.85 (0.48-1.53)	0.75 (0.43-1.32)
There are occupational nurses	5.56 (1.20-25.8)	5.01 (1.37-18.3)
There are prepared forms documents on collaborating with APs in case of employee's returning-to-work	4.21 (2.01-8.82)	1.64 (0.88-3.04)
There are prepared forms documents on collaborating with (referring to) APs in case of supporting the prevention of employees' diseases exacerbation	2.28 (1.21-4.30)	3.63 (1.94-6.79)

Values of odds ratios were adjusted for size of the company occupational physicians belong to (binomial, i.e. whether the number of employees is more than 500 or not)

Ⅴ. 資料

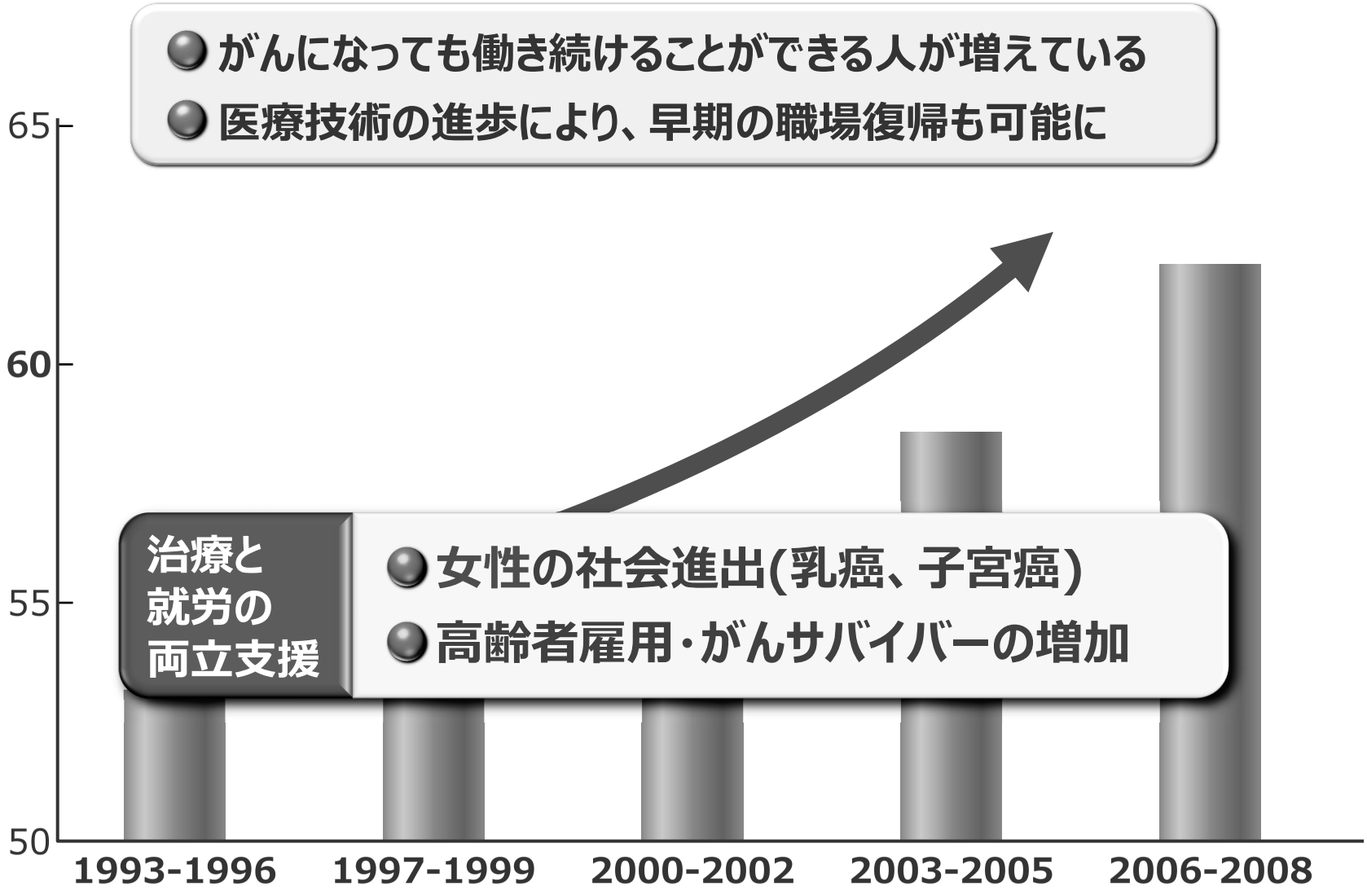
22世紀医療センター
22nd Century Medical and Research Center

シンポジウム11「治療と職業生活の両立支援推進をめざして」

中小企業における がんの治療就労両立支援 の推進に向けて ～企業・産業保健スタッフ・医療機関の 連携による両立支援システムの開発～

東京大学医学部附属病院22世紀医療センター
松平 浩

がんの5年相対生存率(全がん)の推移



地域がん登録に基づき、国立がん研究センターが集計

大企業　0.3%

1,433万人

中小企業 99.7%

3,361万人

平成26年経済センサス – 基礎調査

大企業と中小企業の違い

大企業

- 産業医を含む産業保健スタッフが充実しており医療サイドと連携を取りやすい
- 会社側の制度も充実している場合が多い(配置転換・リハビリ勤務)

中小企業

- 産業保健スタッフは、いないに等しい
- 一人当たりの業務負担が大きい

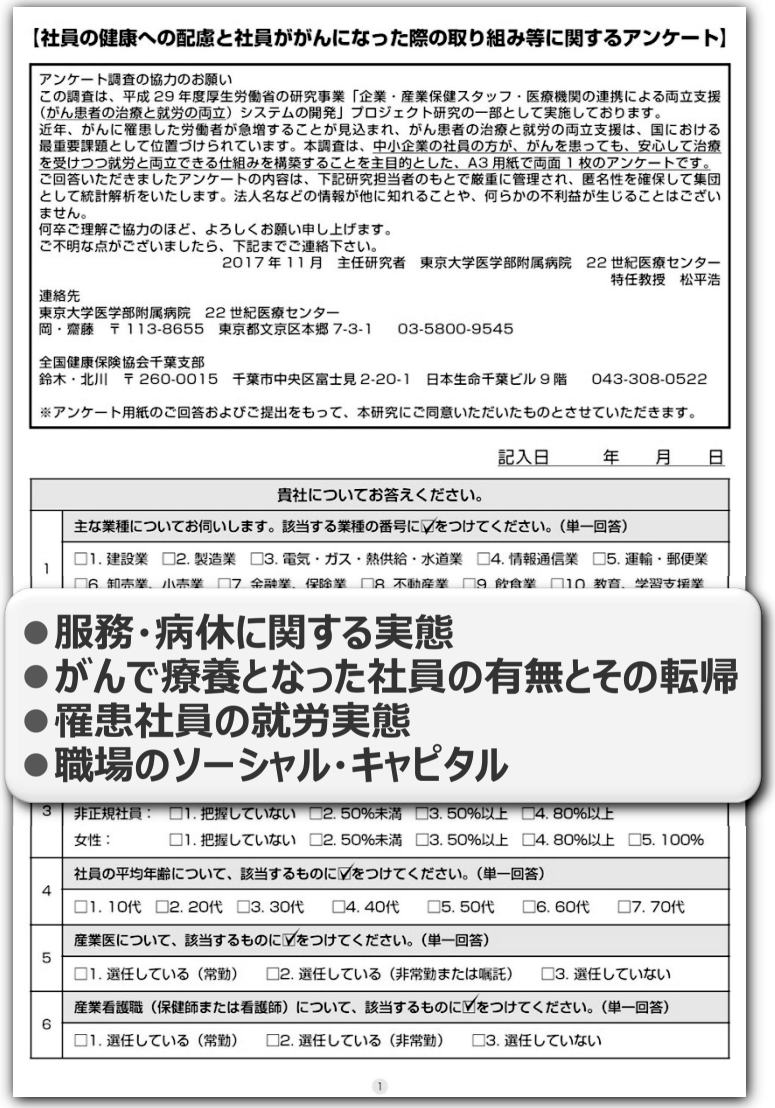
1. 中小企業の両立支援活動評価指標案の作成

＝

中小のがん・治療と就労の両立支援 優良企業認定

目的：「がん治療と仕事の両立」の必要性や意義について企業・社会に広く普及・定着させる

- **当該分野の様々な専門家との意見交換を踏まえ質問票を作成し、事業所に配布**
  - 石川産業保健総合支援センター ／ 一般財団法人京都工場保健会
  - 全国健康保険協会千葉支部 ／ 東京商工会議所サービス・交流部
- **中小企業の現状とニーズを分析**



【社員の健康への配慮と社員ががんになった際の取り組み等に関するアンケート】

アンケート調査の協力のお願い
この調査は、平成29年度厚生労働省の研究事業「企業・産業保健スタッフ・医療機関の連携による両立支援（がん患者の治療と就労の両立）システムの開発」プロジェクト研究の一部として実施しております。
近年、がんに罹患した労働者が急増することが見込まれ、がん患者の治療と就労の両立支援は、国における最重要課題として位置づけられています。本調査は、中小企業の社員の方が、がんを患っても、安心して治療を受けつつ就労と両立できる仕組みを構築することを主目的とした、A3用紙で両面1枚のアンケートです。
ご回答いただきましたアンケートの内容は、下記研究担当者のもとで厳重に管理され、匿名性を確保して集団として統計解析をいたします。法人名などの情報が他に知れることや、何らかの不利益が生じることはございません。
何卒ご理解ご協力のほど、よろしくお願い申し上げます。
ご不明な点がございましたら、下記までご連絡下さい。
2017年11月　主任研究者　東京大学医学部附属病院　22世紀医療センター　特任教授　松平浩

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※アンケート用紙のご回答およびご提出をもって、本研究にご同意いただいたものとさせていただきます。

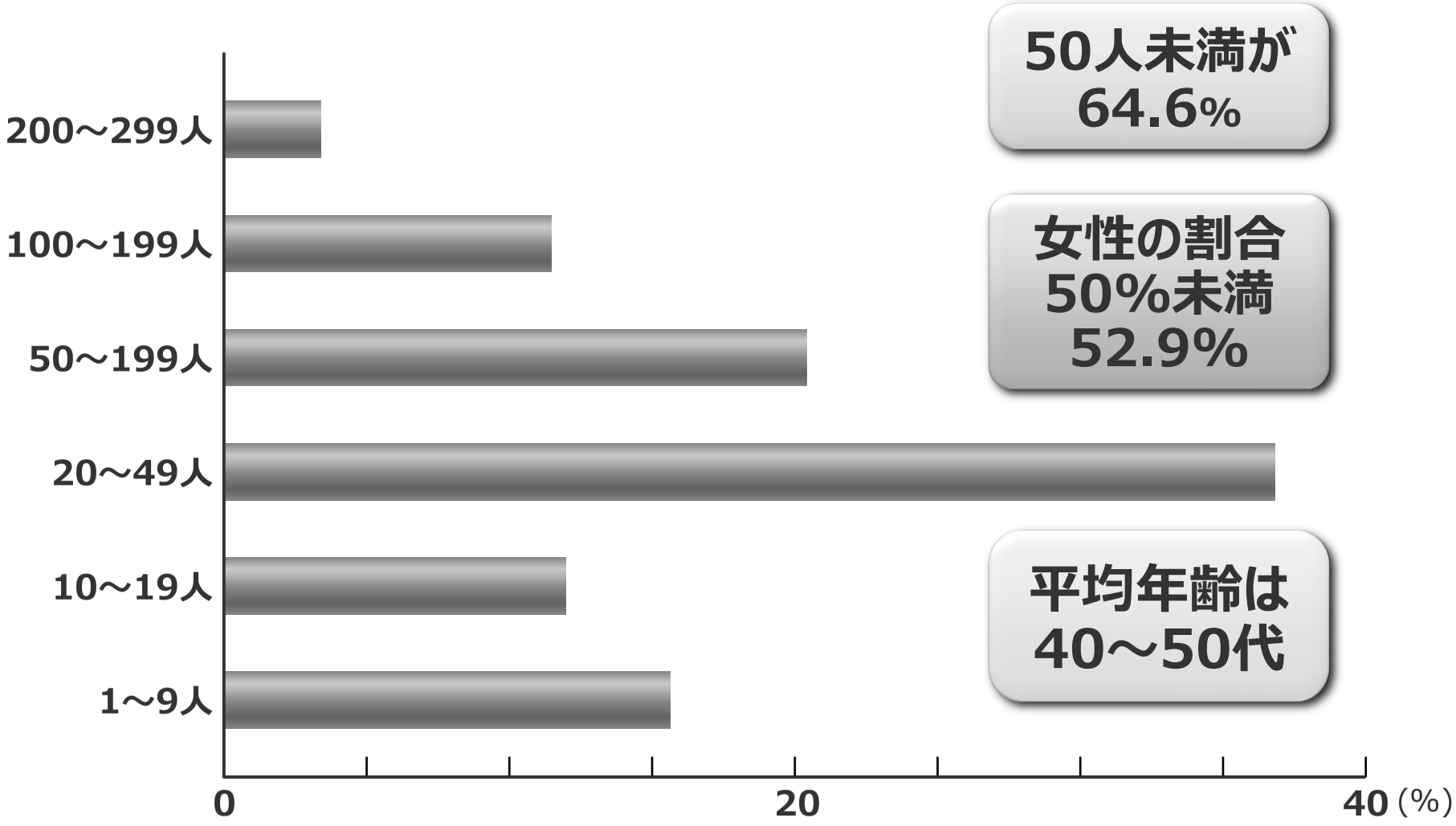
記入日　　年　月　日

	貴社についてお答えください。
1	主な業種についてお伺いします。該当する業種の番号に☑をつけてください。（単一回答） □1. 建設業　□2. 製造業　□3. 電気・ガス・熱供給・水道業　□4. 情報通信業　□5. 運輸・郵便業 □6. 卸売業、小売業　□7. 金融業、保険業　□8. 不動産業　□9. 飲食業　□10. 教育、学習支援業
3	非正規社員：　□1. 把握していない　□2. 50%未満　□3. 50%以上　□4. 80%以上 女性：　□1. 把握していない　□2. 50%未満　□3. 50%以上　□4. 80%以上　□5. 100%
4	社員の平均年齢について、該当するものに☑をつけてください。（単一回答） □1. 10代　□2. 20代　□3. 30代　□4. 40代　□5. 50代　□6. 60代　□7. 70代
5	産業医について、該当するものに☑をつけてください。（単一回答） □1. 選任している（常勤）　□2. 選任している（非常勤または嘱託）　□3. 選任していない
6	産業看護職（保健師または看護師）について、該当するものに☑をつけてください。（単一回答） □1. 選任している（常勤）　□2. 選任している（非常勤）　□3. 選任していない

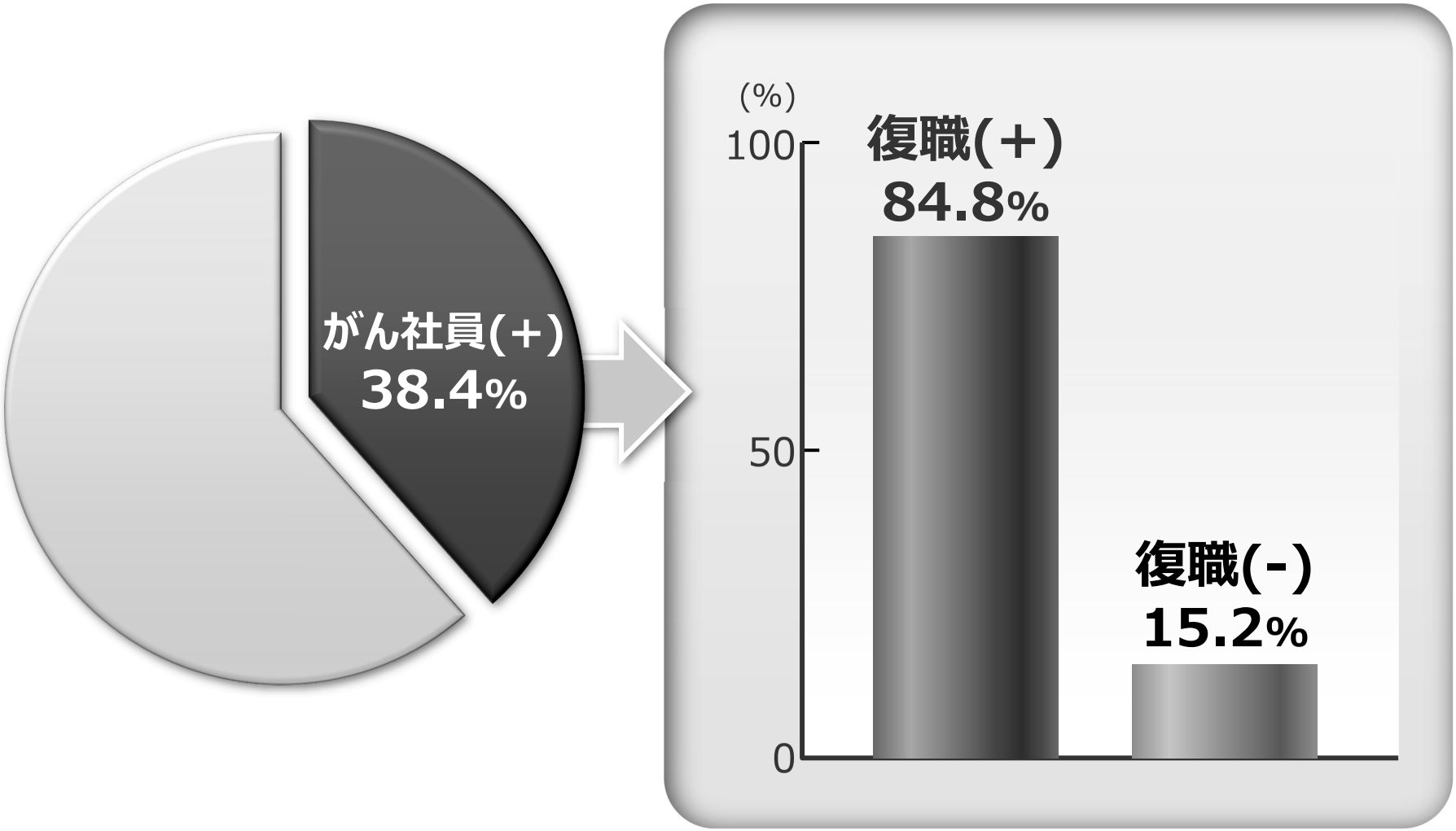
1

- 服務・病休に関する実態
- がんで療養となった社員の有無とその転帰
- 罹患社員の就労実態
- 職場のソーシャル・キャピタル

昨年12月から約5,000社に配布 1,040事業所のアンケート中 300人未満の979事業所を解析



300人未満の事業所(n=979)



がん社員が復職できなかった企業の特徴

①担当・窓口がない

- 病気を理由に休暇や休業をとる際、
  社員が相談できる担当者がいない

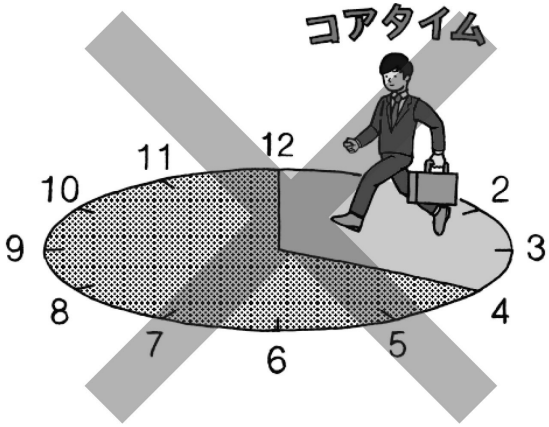
- 病気になっても無理なく働けるよう、
  社員が相談できる窓口がない

がん社員が復職できなかった企業の特徴

②柔軟に対応できる制度がない

- 勤務時間/勤務形態の柔軟な対応(フレックスタイムや時差出勤、短時間勤務など)ができない

- 人事制度を柔軟に運用できていない



がん社員が復職できなかった企業の特徴

③社員教育や周囲の理解が足りない

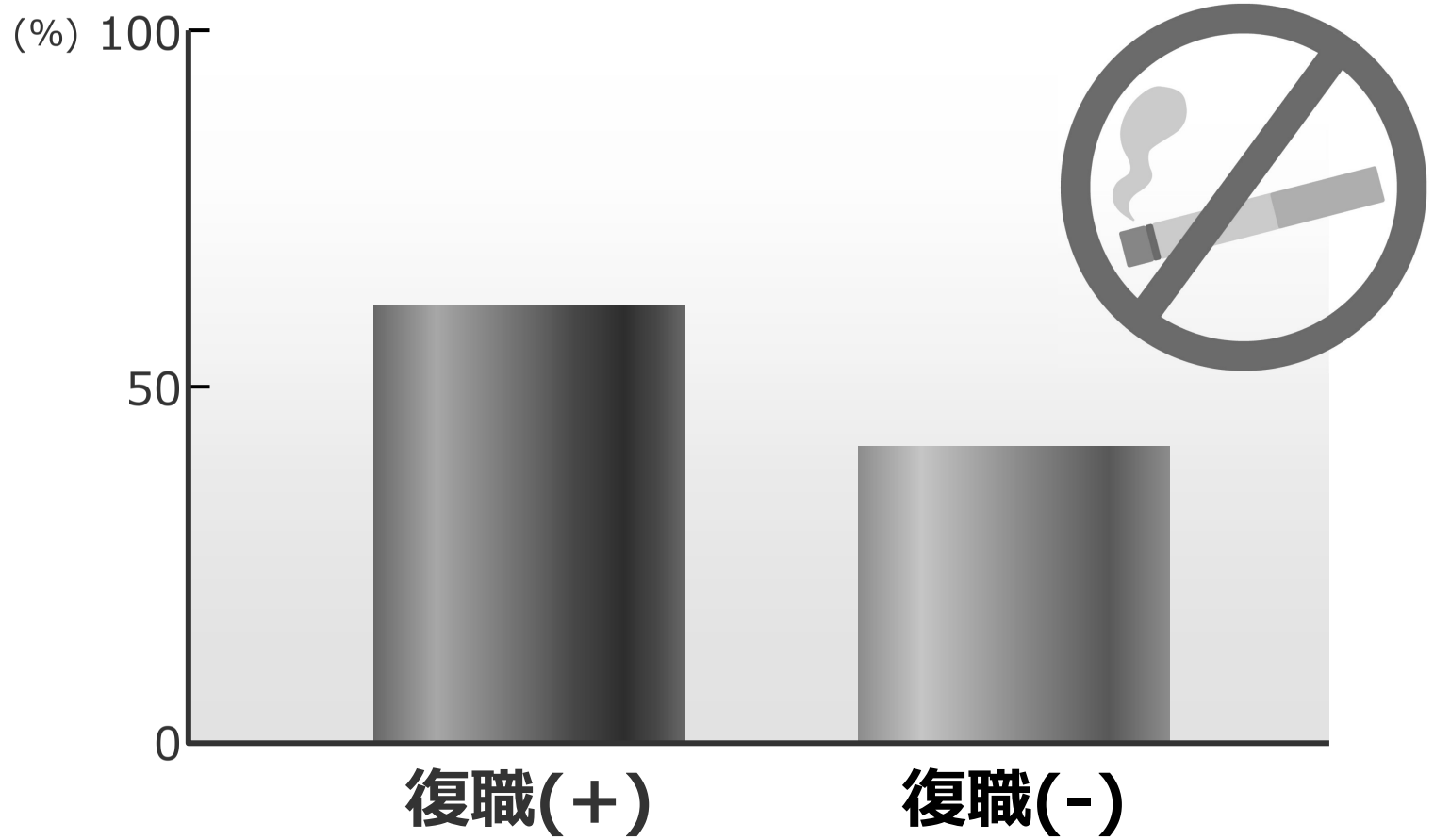
- 治療を続けながら仕事を継続する社員の支援の方法について、社員に教育や啓発を行なっていない

- 職場が<u>両立支援</u>への理解がない

事業主の
負担が大きい

がん社員が復職している企業では「禁煙／受動喫煙」対策を行っている割合が高くなっていました

「禁煙／受動喫煙」対策を行っている割合



中小企業の両立支援活動評価指標案の作成
その活用により

■ 自社の課題が明確になる

例：担当・窓口がない、柔軟に対応できる制度がないなどの課題

■ 治療と仕事の両立に関する従業員の理解促進につながる

社員教育もやりやすくなり、理解も深まる

■ 「禁煙／受動喫煙」対策が推進される・・・

1 企業・経営者への量的研究

アンケート調査による
現状把握・分析

- 両立支援・取組状況の判断基準の提案
- 認知度 up!

2 サポートする人への質的研究

がん両立支援に
携わる人へのフォーカスグループインタビューの
実施と分析

- がん患者やがんに罹患した従業員がいる企業経営者・担当者に安心かつ明確な支援モデルの提案

2. 多様なスタッフに対する質的研究

2017年9月に
フォーカスグループインタビューを実施
インタビュアー：
東京大学大学院教育学研究科
臨床心理学コース 高橋美保 教授

インタビュー協力者（敬称略）

中小企業側

- **吉川　和子**　社労士、医療経営士、健康経営アドバイザー、がん患者・障がい者等就労支援委員会委員
- **原　　麻 子**　社労士、国立がん研究センター主催 がんサバイバーシップオープンセミナーでの講演・がん患者・障がい者等就労支援委員会委員
- **石川　光子**　社労士、障害年金相談件数300件以上、朝日新聞等での取材経験有
- **櫻井　公恵**　がん対策推進企業アクションを推進し就労支援を実践する中小企業経営者

病院側

- **原田　理恵**　労働者健康安全機構 東京労災病院MSW・がん両立支援コーディネーター
- **住吉　千尋**　労働者健康安全機構 中国労災病院MSW・がん両立支援コーディネーター
- **高橋　雅人**　東京大学医学部附属病院 リハビリテーション部副技師長、がんリハビリテーションのチーフPT
- **梅﨑　成子**　東京大学医学部附属病院　リハビリテーション部OT、高次機能障害患者に対する支援を実施
- **海津未希子**　慶應義塾大学大学院健康マネジメント研究科後期博士課程、がん専門看護職

病院側と企業側の間の産業保健総合支援センターの立場

- **小山　善子**　石川産業保健総合支援センター所長、両立支援促進員の役割等を熟知

実施時間：約3時間半(録画・録音)

①問題点の整理:
7カテゴリ 22サブカテゴリ 220重要アイテム

高橋美保ら. 東京大学大学院教育学研究科臨床心理コース紀要 41(in press)

②解決策: 6 … 重要アイテム

職場

⑤産保セ…
対策:産…
コーディネ…

スク…
雇用…

⑥両…
コーディネータ…
対策:所属…
コーディネー…

相談窓口…
対策:援助の…

①医療システム…
対策:意見書の保…
スクリーニングのシ…

患者

- (新)療養・就労両立支援指導料 1,000点(6月に1回)
- 相談体制充実加算 500点

がん診断…

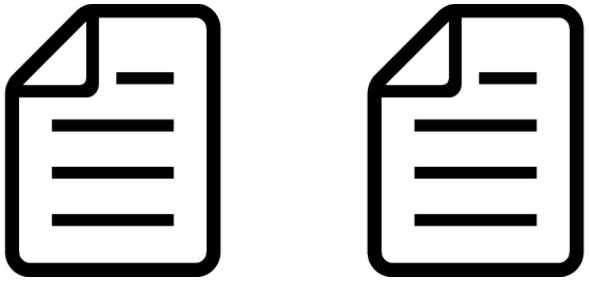
…の連携による支援
…ディネーター同士の連携、
…柔軟な支援

…ター
労士
場
OT
…ネータ

…後の日々
…発・病勢増悪

選択制がん罹患社員用就業規則標準フォーマット

- 50-1000名(小-中規模)の企業では、総務人事労務担当者が少数。
- がん罹患社員に対し、何をすればよいのか分からないと考える担当者が多い。



柔軟な期間限定的勤務制度
（復職から1-2年間）
例：短時間勤務制度、在宅勤務制度、
軽作業への変更、特別病休付与等

多くの総務人事労務担当者がそれぞれの企業に合わせた形で、
選択制のがん罹患社員用就業規則を設けやすくなる

1 企業・経営者への量的研究

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がんの両立支援に携わる人へのフォーカスグループインタビューの実施と分析

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謝辞（敬称略）

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