報告者	報告年	対象	調査方法	対象者等	結果
S. C. Darby ら	1987	放射線治療	cohort	14,106 人	強直性脊椎炎の治療患者 (多発性骨髄腫発症例 8 例) O/E=8/4.66=1.72 (有意ではない) 治療後の年数が経過するにしたがって多発性骨髄腫が増加 5 年> 0/0.33、5-25 年 4/2.63、25 年< 4/2.03
J. D. Boice ら	1985	放射線治療子宮頚がん (8 か国)	cohort	82,616 人/ 14,173 人	放射線治療群 O/E=33/35=1.0 10 年以上追跡例 O/E=22/15=1.4 放射線治療以外の治療群 O/E=1/4.0=0.3 10 年以上追跡例 O/E=1/1.8=0.5 放射線治療後の経過年数が長くなるにしたがって発生率が高くなる(傾向分析 : p=0.01)、治療後 10 年未満 RR=0.6(95% CI:0.3-1.0)、15 年以上 RR=2.0(95% CI: 1.1-3.2)で有意に増加
M. Andersson ら	1992	放射線診断	cohort	999 人	多発性骨髄腫 : 4 例(女性) SIR=4.6(90% CI:1.2-12) 脳血管造影のためのトロトラスト投与患者
M. Andersson ら [35]	1993	放射線診断	cohort	1,003 人(2 例)	多発性骨髄腫 2 例 赤色骨髄線量 : 1.02、1.75Gy
P. Boffetta ら [36]	1989		case-control	282 人/770 人	放射線治療 : OR=1.4(0.8-2.6), 放射線診断 OR=0.9(0.6-1.4) 職業被ばく : OR=1.4(0.5-3.9)多発性骨髄腫の発生と放射線との関係は negative
S. C. Darby ら [37]	1985	放射線治療			(強直性脊椎炎)平均骨髄線量:335rad RR=1.78(3 例) 両者を combined すると RR=2.16(95% CI:1.11-4.20、p<0.05)
		原爆被爆者			(100rad 以上)平均骨髄線量:125rad RR=1.40(4 例)
原子力施設等周辺住民を対象にした疫学調査					
D. Forman ら	1987	施設周辺住民			イングランド及びウェールズの核施設周辺施設周辺の住民の多発性骨髄腫の RR=0.79(p=0.016), ただし、海岸地域の住民の多発性骨髄腫の RR=1.11(p=0.04) である。Winfrit、Sellafield 施設周辺の距離が近いほど多発性骨髄腫の SMR は増加するが統計的に有意ではない(p=0.223、0.640)

報告者	報告年	対象	調査方法	対象者等	結果
M. Dousset	1989	施設周辺住民		7,408 人/ 459,460 人	(La Hague のある区域の多発性骨髄腫の死亡率) O/E Male :1/0.58(p=0.44) Female:2/0.54(p=0.11)
J. B. Boice Jr, ら	2003	ウラン鉱山周辺住民		12,455/ 43,546 人 (1950-2001 年)	多発性骨髄腫 O/E:22/52 RR=1.37(統計的に有意ではない) 全てのがん RR=1.0
G. Lopez-abente ら	1999	Spain 原子力施設周辺住民			7 原子力発電所、5 核燃料施設 施設周辺の 30km 以内(122 例) control: 施設周辺 50-100km(100 例) Zorita 原子力発電所周辺のみ有意 SMR(control:0.308, 0-15km:1.744, 0-30 km:1.343) RR(0-15km:5.653, 0-30km:4.354) 施設からの距離と RR は有意な傾向(p=0.0164) 特に 13.4-18.9km の RR=8.120 が影響している
P. Vineis ら [38]	1990		case/control	骨髄腫患者 400 例	有機溶剤、放射線、電磁界への暴露を調査
R. J. Black ら [39]	1994	Scotland (Ra-226 汚染)			O/E=1.08(2 例)有意な増加は認められない。

表２　多発性骨髄腫による死亡の線量反応関係

疫学調査	集積線量(mSv)							time lag	trend test	subject size等
	0-	10-	20-	50-	100-	200<				
Hanford (1993)	17/17.0	2/4.9		2/0.9	1/0.6	2/0.6		10年	1.99 (p=0.011)	1945-1989年 32,643人(26.2mSv)
USA 4 facilities (2000)	Odds比 1.0 (83/341)	0.77 (5/31)		3.55 (3/7)	5.15 (7/12)					多発性骨髄腫：98例 対照群：391例 (45歳以上)
3 countries (1995)	28/26.6	3/5.2	1/4.7	5/2.7	3/2.1	200- 2/1.9	400- 2/0.8	10年	1.87 (p=0.037)	US、UK、Canada 95,673人
日本 原子力施設 (2003)	1.00 (6)	0.00 (0)	0.00 (0)	3.63 (1)	4.22 (1)			0年	p=0.047	1991-1997年 119,484人(平均追跡期間4.5年、15.3mSv)
BNF (1999)	0/1.3	0/0.8	2/1.5	3/1.2	1/1.1	200- 0/1.1	400< 2/1.0	10年	1.44	1947-1992年 14,385人 (平均29.0年) 1,352,326mSv(total)
								20年	2.53 (p=0.017)	
UK 原子力施設 (1999)	20/20.14	4/4.85	3/6.66	8/3.46	0/2.39	200- 3/1.70	400< 2/0.79		1.67 (p=0.059)	-1992年 124,743人(30.5mSv)
Hiroshima (1994)	<0.01(Gy) 29/30.43	0.01-4(Gy) 30/28.57 (fitness excess = 0.00)							(-)	1950-1987年 86,293人(4Gy>)
UK Veterans (1988)	1.14	0	0	0	100< 0			10年	0.12 (-)	1951-1982年 22,552人(7.8mSv)

(表中：Observed/Expected)

多発性骨髄腫に関する疫学調査の文献一覧

1. M. Ichimaru et al. : Multiple myeloma among atomic bomb survivors in Hiroshima and Nagasaki, 1950-76.: Relationship to radiation dose absorbed by marrow. JNCI 69, 323-328 (1982)

2. D. L. Preston et al. : Studies of the mortaslity of A-Bomb Survivors,. 8. Cancer Mortality, 1950-1982. Radiat Res 111, 151-178 (1987)

3. Y. Shimizu et al. : Studies of the mortality of A-bomb survivors. 9. Mortality, 1950-1985 : Part 2. Cancer mortality based on the recently revised doses (DS86). Radiat Res 121, 120-141 (1990)

4. Y. Shimizu et al. : Mortality among Atomic Bomb Survivors. J Radiat Res 32 (Suppl) 212-230 (1991)

5. D. L. Preston et al. : Cancer incidence in atomic bomb survivors. Part 3. leukemia, lymphoma and multiple myeloma, 1950-1987. Radiat Res 137 (2 Suppl) : S68-S97 (1994)

6. H. D. Tolley et al. : A further update of the analysis of mortality of workers in a nuclear facility. Radiat Res 95, 211-213 (1983)

7. E. S. Gilbert et al. : Mortality of workers at Hanford site : 1945-1981, Health Phys 56, 11-25 (1989)

8. E. S. Gilbert et al. : Mortality of workers at the Hanford site: 1945-1986. Health Phys 64, 577-590 (1993)

9. S. Wing et al. : A case control study of multiple myeloma at four nuclear facilities. Ann Epidemiol 10, 144-153 (2000)

10. E. S. Gilbert et al. : Analyses of combined mortality data on workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Nuclear Weapons Plants. Radiat Res 120, 19-35 (1989)

11. P. G. Smith et al. : Mortality of workers at the Sellafield plant of British Nuclear Fuels. BMJ 293, 845-854 (1986)

12. A. J. Douglas et al. : Cancer mortality and morbidity among workers at the Sellafield plant of British Nuclear Fuels. Br J Cancer 70, 1232-1243 (1994)

13. R. Z. Omar et al. : Cancer mortality and morbidity among plutonium workers at the Sellafield plant of British Nuclear Fuels. Br J Cancer 79, 1288-1301 (1999)

14. G. M. Kendall et al. : Mortality and occupational exposure to radiation : first analysis of the National Registry for Radiation Workers. BMJ 304, 220-225 (1992)

15. C. R. Muirhead et al. : Occupational radiation exposure and mortality: second analysis of the National Registry for Radiation Workers. J Radiol Prot 19, 3-26 (1999)

16. E. Cardis et al. : Effects of low doses and low dose rates of external ionizing radiation: cancer mortality among nuclear industry workers in three countries. Radiat Res 142, 117-132 (1995)

17. T. Iwasaki et al. : Second analysis of mortality of nuclear industry workers in Japan, 1986-1997 Radiat Res 159, 228-238 (2003)

18. J. X. Wang et al. : Cancer among medical diagnostic x-ray workers in China. JNCI 80, 344-350 (1988)

19. L. Tomasek et al. : Radon exposure and cancers other than lung cancer among uranium miners in west Bohemia. Lancet 341, 919-923 (1993)

20. V. Beral et al. : Mortality of employees of the Atomic Weapons Establishment, 1951-82. BMJ 297, 757-770 (1988)

21. S. C. Darby et al. : A summary of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom' s atmospheric nuclear weapon tests and experimental programmes. BMJ 296, 332-338 (1988)

22. S. C. Darby et al. : Further follow up of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom' s atmospheric nuclear weapon tests and experimental programmes. BMJ 307, 1530-1535 (1993)

23. C. R. Muirhead et al. : Follow up of mortality and incidence of cancer 1952-98 in men from the UK who participated in the UK' s atomospheric nuclear weapon tests and experimental programmes. Occup Enciron Med 60, 165-172 (2003)

24. N. Pearce et al. : Follow up of New Zealand participants in British atmospheric nuclear weapons tests in the Pacific. BMJ 300, 1161-1166 (1990)

25. J. L. Hatcher et al. : Diagnostic radiation and the risk of multiple myeloma (United States). Cancer Causes Control 12, 755-761 (2001)

26. P. D. Inskip et al. : Leukemia, lymphoma, and multiple myeloma after pelvic radiotherapy for benign disease. Radiat Res 135, 108-124 (1993)

27. S. C. Darby et al. : Mortality in a cohort of women given X-ray therapy for metropathia haemorrhagica. Int J Cancer 56, 793-801 (1994)

28. S. C. Darby et al. : Long term mortality after a single treatment course with x-rays in patients treated for ankylosing spondylitis. Br J Cancer 55, 179-190 (1987)

29. J. D. Boice Jr. et al. : Second cancer following radiation treatment for cervical cancer An international collaboration among cancer registries. JNCI 74, 955-975 (1985)

30. M. Andersson et al. : Cancer incidence among Danish Thorotrast-exposed patients. JNCI 84, 1318-1325 (1992)

31. D. Forman et al. : Cancer near nuclear installations. Nature 329, 499-505 (1987)

32. M. Dousset : Cancer mortality around La Hague nuclear facilities. Health Phys 56, 875-884 (1989)

33. J. D. Boice Jr. et al. : Cancer mortality in a Texas county with prior uranium mining and milling activities, 1950-2001. J Radiol Prot 23, 247-262 (2003)

34. G. Lopez-Abente et al. : Leukemia, lymphomas, and myeloma mortality in the vicinity of nuclear power plants and nuclear fuel facilities in Spain. Cancer Epidemiol Biomarkers Prev 8, 925-934 (1999)

35. M. Andersson et al. : Leukemia and other related hematological disorders among Danish patients exposed to Thorotrast. Radiat Res 134, 224-233 (1993)

36. P. Boffetta et al. : A case - control study of multiple myeloma nested in the American Cancer Society prospective study. Int J Cancer 43, 554-559 (1989)

37. S. C. Darby et al. : A parallel analysis of cancer mortality among atomic bomb survivors and patients with ankylosing spondylitis given X-ray therapy. JNCI 75, 1-21 (1985)

38. P. Vineis et al. : Italian Multicentre Case-Conttrol Study of Hematolymphopoietic Malignancies. Med Lav 81, 506-512 (1990)

39. R. J. Black et al. : Cancer incidence in a population potentially exposed to radium-226 at dalgety Bay, Scotland. Br J Cancer 69, 140-143 (1994)