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| **Table 1. Characteristics of studies that reported the relationship between dairy products and risk of osteoporosis** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Authors (year)** | **Country** | **Age range** | | **Gender** | | | **Number** | **Number of cases** | **Duration follow-up (y)** | | **Exposure variable** | | **Exposure assessment** | **Outcome variable**  **(Definition)** | **Outcome assessment** | **Comparison** | | **Results** | | | | | **Study quality** | **Matching or Adjustments** | |
| **OR or RR (95%CI)** | | | **R**  **(P-value)** | |
| 1. **Cohort studies** | | | | | | | |  | | | | | | | | | | | | |  | | | | |
| Thomas-john  (2009) | US | | 70< | | M | | 257 | 17 | 3 y | | Dairy | Questionnaire | | WHO criteria for Osteoporosis | BMD by DEXA  Lunar | | gr/d | | 1.02(1.0-1.04) | |  | | 4 | | - |
| Shin  (2010) | Korea | | 40-70 | | F | | 1277 | 302 | 5 y | | Dairy | FFQ | | WHO criteria for Osteoporosis | BMD by DEXA  Hologic | | >1 time/d vs. 2-3 time/w | | 0.79(0.53-1.16) | |  | | 5 | | 1-11 |
| Matthews  (2011) | US  Canada | | 54-75 | | F | | 337 | 100 | 4 y | | Dairy | FFQ | | WHO criteria for Osteoporosis | BUA | | +30/m vs. 0-7/m | | 0.38(0.17-0.86) | |  | | 6 | | 1,2,8,12-14 |
| Laird  (2017) | Ireland | | 60-102 | | F  M | | 2905  1405 | 360  104 | 2 y | | Yogurt | FFQ | | WHO criteria for Osteoporosis | BMD by DEXA  Lunar | | Daily vs. no | | 0.48(0.24-0.96)  0.61(0.42-0.89) | |  | | 6 | | - |
| Milk | 1.58(0.99-2.52)  0.75(0.49-1.13) | |
| Cheese | 2.36(1.16-4.82)  1.18(0.70-2.00) | |
| 1. **Case-control studies** | | | | | | | |  | | | | | | | | | | | | |  | | | | |
| Woodson  (2004) | US | | 45-71 | | | F | 102 | 56 | | - | Dairy | Self-reported Questionnaire | | WHO criteria for Osteoporosis | BMD by DEXA  Hologic | | Regularly vs. avoid | | 0.79 (0.27-2.31) | |  | 4 | | | - |
| Keramat  (2008) | Iran | | 44-72.5 | | | F | 363 | 178 | | - | Milk | FFQ | | WHO criteria for Osteoporosis | BMD by DEXA  Lunar | | >=1 cup/d vs. <1 | | 0.6(0.3-0.9) | |  | 7 | | | 1, 15, 16 |
| Cheese | >=30 gr/d vs. <30 | | 0.5(0.3-0.9) | |
| Grgurevic  (2010) | Serbia | | 44-84 | | | F | 200 | 100 | | - | Milk | MEDOS questionnaire | | WHO criteria for Osteoporosis | BMD by DEXA  Lunar | | Daily vs. not daily | | 0.48(0.27-0.85) | |  | 5 | | | - |
| Cheese | 0.45(0.25-0.82) | |
| Dairy | 0.45(0.25-0.80) | |
| 1. **Cross-sectional studies** | | | | | | | |  | | | | | | | | | | | | |  | | | | |
| Shaw  (1993) | Taiwan | | 15-83 | | | F  M | 266  138 | 41  14 | | - | Milk | Questionnaire | | Osteoporosis  BMD<1 g/cm2 | BMD by DPA  Lunar | | >=2 times/week vs. <2 times/week | | F: 0.40(0.18-0.88)  M:1.97(0.65-6.06) | |  | 4 | | | - |
| Hong  (2013) | Korea | | 20< | | | F, M | 9444 | 1468 | | - | Dairy | - | | Asian criteria for osteoporosis  BMD< -2.5 T-score | BMD | | 1< serving vs. 0 serving | | 0.71(0.53-0.96)  Ptrend=0.0334 | |  | 5 | | | 1, 2, 5-7, 12, 17, 18 |
| Irvin  (2013) | UK | | 26-77 | | | F | 590 | 44 | | - | Milk | Questionnaire | | osteoporosis | Questionnaire | | >+1 time/d vs. <1 time/d | | 1.05(0.56-1.99) | |  | 3 | | | - |
| Wadolowska  (2013) | Poland | | 29-59 | | | F | 150 | 140 | | - | Dairy | ADOS-Ca questionnaire | | Osteoporosis  BMD< -1 SD | BMD by DEXA | | >=28 Serving/w vs. <28 serving/w | | 1.36(0.23-7.88) | |  | 7 | | | 1, 2, 7 |
| Alquaiz  (2014) | Saudi Arabia | | 41-85 | | | F | 1008 | 735 | | - | Milk  Cheese | Questionnaire | | Osteoporosis  BMD< -1 | BMD by QUS  Lunar | | 200 ml/d vs. no  100 mg/d vs. no | | 0.70(0.51-0.96)  0.68(0.50-0.95) | |  | 5 | | | - |
| Jahanbin  (2014) | Iran | | 43-63 | | | F | 1170 |  | | - | Dairy | questionnaire | | WHO criteria for Osteoporosis | BMD by DEXA  Femoral neck, lumber spine | |  | |  | Significant correlation  P<0.05 | | 3 | | | - |
| Lim  (2015) | Korea | | >50 | | | F | 1355 | 449 | | - | Dairy | 24-h recall | | WHO criteria for Osteoporosis | BMD by DEXA  Hologic | | T3 vs. T1 | | 0.40(0.21-0.75) | |  | 7 | | | 1 |
| Hammad  (2017) | Saudi Arabia | | 20-24.9 | | | F | 101 | 35 | | - | Dairy | FFQ | | BMD< -1 T-score | BMD by DEXA  Lunar | | 3-5 times/w vs. <2 times/w | | 0.34(0.06-1.82) | |  | 4 | | | - |
| 1-age, 2-BMI, 3-alcohol consumption, 4-smoking, 5-physical activity, 6-age at menarche, 7-age at menopause, 8-education level, 9-house income, 10-menopause duration, 11-menopause causes, 12-Estrogen use, 13-vegetarian status, 14-soy milk intake, 15-height, 16-weight, 17-gender, 18-serum vitamin D level  F=female, M=male, WHO= world health organization, BMD= bone mineral density, DPA= dual-photon absorptiometry, DEXA= dual-energy x-ray absorptiometry, BUA= broad-band ultrasound attenuation, QUS= quantitative ultrasound, ADOS-Ca= dairy products frequency questionnaire, MEDOS= Mediterranean osteoporosis study questionnaire, FFQ=food frequency questionnaire | | | | | | | | | | | | | | | | | | | | | | | | | |

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| **Table2. Characteristics of studies that reported the relationship between dairy products and risk of fracture.** | | | | | | | | | | | | | | | | | | | |
| **Authors (year)** | **Country** | **Age range** | **Gender** | | **Number** | **Number of case** | **Duration follow-up (y)** | | **Exposure variable** | | **Exposure assessment** | | **Outcome variable** | **Outcome assessment** | **Comparison** | | **OR or RR (95%CI)** | **Study quality** | **Matching or Adjustments** |
| 1. **Cohort studies** | | | | | | | | | | | | | | | | | | | |
| Cumming (1997) | US | >65 | F | 9704 | | 1639 | | 6 | Milk | FFQ | | Hip fracture | | Radiography | | >=3 glass/d vs. <1 glass/d | 0.9 (0.5-1.7) | 7 | 1-16 |
| Ankle fracture | | 0.4 (0.2-0.9) |
| Proximal humeral fracture | | 1.2 (0.6-2.4) |
| Wrist fracture | | 0.8 (0.5-1.4) |
| Vertebral fracture | | 1.4 (0.8-2.3) |
| Fujiwara (1997) | Japan | 45-71 | F,M | 4573 | | 55 | | 14 | Milk | FFQ | | Hip fracture | | x-ray examination | | >=5 /w vs. <=1/w | 0.54 (0.25-1.07) | 5 | - |
| Meyer (1997) | Norway | 35-49 | M | 19752 | | 56 | | 6 | Milk | questionnaire | | Hip fracture | | Medical report | | >=5 glass/d vs. <=1 glass/d | 0.83 (0.44-1.56) | 6 | 1, 9, 17-22 |
| F | 20035 | | 154 | | 0.46 (0.22-0.98) |
| Turner (1998) | US | 50< | F | 2325 | | 195 | | 4 | Dairy | questionnaire | | Fracture | | Questionnaire | | >=2 time/d vs. <2 | 1.49 (1.12-1.98) | 5 | - |
| Turner (1999) | US | 50< | F | 2156 | | 180 | | 4 | Dairy | questionnaire | | Hip fracture | | Questionnaire | | >=2 time/d vs. <2 | 1.53 (1.14-2.06) | 5 | - |
| Roy DK  (2003) | European countries | 50-79 | M  F | 3173  3402 | | 48  116 | | 4 | Milk | questionnaire | | Vertebral fracture | | Radiography | | >=1 glass/d vs. <1 glass/d | M 0.74(0.44-1.26)  F1.04(0.71-1.50) |  | 1, 2 |
| Nevitt (2005) | US | 65-99 | F | 5822 | |  | | 4 | Milk | FFQ | | vertebral fractures | | Radiography | | >+7 glass/w vs. <7 | 0.99 (0.85-1.15) | 7 | 1, 2 |
| Nieves (2010) | US | 16-26 | F | 125 | | 17 | | 2 | Dairy | FFQ | | Stress fracture | | Radiography | | Cup/d | 0.60(0.40-0.89) | 5 | 1, 2, 5, 23 |
| Skim milk | 0.38(0.16-0.90) |
| Total Milk | 0.43(0.20-0.89) |
| Feart (2013) | France | 68-95 | F, M | 1435 | | 155 | | 8 | Yogurt | FFQ | | Hip fracture | | Self-report | | <6 serving/w vs. >6 serving/w | 1.11 (0.62–1.99) | 6 | 1, 4, 9, 14, 15, 18, 21, 24-27 |
| Vertebral fracture | | 0.85 (0.42–1.70) |
| Wrist fracture | | 1.98 (1.22–3.21) |
| Fracture | | 1.29 (0.92–1.81) |
| Milk | Hip fracture | | <0.25 serving/w vs. >0.25 serving/w | 1.16 (0.67–2.02) |
| Vertebral fracture | | 1.15 (0.60–2.20) |
| Wrist fracture | | 0.96 (0.59–1.56) |
| Fracture | | 1.10 (0.79–1.53) |
| Cheese | Hip fracture | | <7 serving/w vs. >7 serving/w | 1.28 (0.72–2.28) |
| Vertebral fracture | | 1.55 (0.80–2.99) |
| Wrist fracture | | 0.98 (0.59–1.62) |
| Fracture | | 1.14 (0.81–1.61) |
| Dairy | Hip fracture | | <17 serving/w vs. >17 serving/w | 0.95(0.54-1.68) |
| Vertebral fracture | | 1.53(0.97-2.95) |
| Wrist fracture | | 2.03(1.22-3.39) |
| Fracture | | 1.51(1.07-2.11) |
| Sahni (2013) | US | 26-85 | F,M | 3224 | | 43 | | 12 | Milk | FFQ | | Hip fracture | | Hospital report | | T3 vs. T1 | 0.50(0.22-1.13) | 7 | 1, 3, 12, 14, 15,17, 22, 23, 25, 26 |
| Yogurt | 0.57(0.19-1.68) |
| Fluid dairy | 0.40(0.17-0.99) |

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| **Table2. Continued.** | | | | | | | | | | | | | | | | | | |
| **Authors (year)** | **Country** | **Age range** | **Gender** | **Number** | **Number of case** | | **Duration follow-up (y)** | **Exposure variable** | **Exposure assessment** | **Outcome variable** | | | **Outcome assessment** | **Comparison** | **OR or RR (95%CI)** | **Study quality** | **Matching or Adjustments** | |
| Sahni (2014) | US | 68-96 | F,M | 764 | 97 | | 50 | Milk | FFQ | Hip fracture | | | Hospital report | >=7 glass/d vs. <=1 glass/d | 0.58(0.31-1.06) | 6 | 1, 3, 14, 15, 17, 22, 25, 26 | |
| Yogurt | Yes vs. no | 1.09(0.65-1.81) |
| Cheese | >1 serving/d vs. <=1serving/d | 0.72(0.48-1.08) |
| Benetou (2013) | 8 European country | 35-70 | M | 48814 | 190 | | 9 | Dairy | FFQ | Hip fracture | | | Hospital record  Self-report | gr/d | 0.97(0.83-1.14) | 6 | 1, 5, 9, 12, 17-19, 22, 23, 25-29 | |
| Milk | 0.96(0.82-1.12) |
| Cheese | 1.05(0.92-1.20) |
| F | 139981 | 612 | | Dairy | 0.93(0.84-1.03) |
| Milk | 0.93(0.84-1.02) |
| Cheese | 1.00(0.91-1.09) |
| Michelsson  (2014) | Sweden | 39-74 | F | 61433 | 17252 | | 20 | Milk | FFQ | Hip fracture | | | Hospital record | >=3 glass/d vs. <1 glass/d | 1.60(1.39-1.84) | 6 | 1, 9, 12, 14, 15, 17, 18, 22, 26, 27, 30-33 | |
| Fracture | | | 1.16(1.08-1.25) |
| 45-79 | M | 45339 | 5379 | | Hip fracture | | | 1.01(0.85-1.20) |
| Fracture | | | 1.03(0.94-1.11) |
| Feskanich  (2018) | US | 34-60  50-75 | F  M | 80600  43306 | 2138  694 | | 20.8  17.5 | Milk | FFQ | Hip fracture | | | Self-report Questionnaire | >=2 s/d vs. <1 s/w | F:0.82(0.70-0.95)  M:0.72(0.54-0.96) | 7 | - | |
| Cheese | >=1 s/d vs. <1 s/w | F:0.94(0.80-1.11)  M:0.96(0.71-1.29) |
| Yogurt | >=5s/w vs. never | F:0.90(0.73-1.10)  M:1.17(0.92-1.49) |
| Dairy | >=4 s/d vs. <1 s/d | F:0.82(0.68-0.99)  M:0.76(0.55-1.06) |
| Michelsson  (2018) | Sweden | 39-74 | F | 61240 | 5827 | | 22 | milk | FFQ | Hip fracture | | | Self-report Questionnaire | >=3 glass/d vs. <1 glass/d | 1.43 (1.13-1.82)  1.38 (1.15-1.66)  2.05 (1.61-2.61) | 6 | - | |
| Fermented milk (yogurt, soured milk) | >=2 serving/d vs. 0 serving/d | 0.68 (0.51-0.89)  0.74 (0.64-0.86)  0.79 (0.66-0.95) |
| 1. **Case-control studies** | | | | | | | | | | | | | | | | | | |
| Cumming (1994) | Australia | 65-100 | F,M | 416 | 209 | - | | Dairy | FFQ | | Hip fracture | | Hospital record | Q5 vs. Q1 | 1.7(0.5-5.4) | 6 | | 1, 25, 34-36 |
| Johnell (1995) | 6 European country | >50 | F | 5618 | 2086 | - | | Milk | questionnaire | | Hip fracture | | Medical report | Q4 vs. Q1 | 0.77(0.66-0.89) | 3 | | - |
| Tavani (1995) | Italy | 45-74 | F | 960 | 241 | - | | Milk  Cheese | questionnaire | | Hip fracture | | Medical report | T3 vs. T1 | 1.0(0.6-1.6)  1.0(0.7-1.5) | 5 | | 1, 12, 18, 22, 27, 30 |
| Suzuki (1997) | Japan | 65-89 | F,M | 747 | 249 | - | | Milk | FFQ | | Hip fracture | | Hospital record | >=2 glass/d vs. never | 1.86(0.84-4.14) | 6 | | - |
| Mosquera (1998) | Argentina | 50< | F,M | 492 | 246 | - | | Dairy |  | | Proximal femur fracture | | Hospital record |  | Increased risk of fracture by decreased intake of dairy |  | | - |
| Kanis (1999)  Medos | 6 European country | 50< | M | 1862 | 730 | - | | Milk  Cheese | questionnaire | | Hip fracture | | Medical report | Q5 vs. Q1 | 0.94(0.57-1.57)  0.40(0.25-0.63) | 6 | | 1, 2, 18 |
| **Table2. Continued.** | | | | | | | | | | | | | | | | | | |
| **Authors (year)** | **Country** | **Age range** | **Gender** | **Number** | **Number of case** | **Duration follow-up (y)** | | **Exposure variable** | **Exposure assessment** | | **Outcome variable** | | **Outcome assessment** | **Comparison** | **OR or RR (95%CI)** | **Study quality** | | **Matching or Adjustments** |
| Jitapunkul (2001) | Thailand | 50< | F | 120 | 60 | - | | Milk | questionnaire | | Hip fracture | | Questionnaire | No regular vs. regular | 3.84(1.31-11.23) | 7 | | 37-46 |
| Hagino (2004) | Japan | 45< | F | 382 | 140 | - | | Milk  Cheese | FFQ | | Distal radius fracture  Proximal humerus fracture | | Hospital record |  | No relation | 3 | | - |
| Slavens (2006) | US | 50-89 | F,M | 2734 | 1366 | - | | Milk | FFQ | | Hip fracture | | Hospital record | >15cup/w vs. 0-1 cup/w | 1.12(0.91-1.38) | 4 | | - |
| Jha (2010) | India | 50-82 | F,M | 200 | 100 | - | | Milk | FFQ | | Hip fracture | | Hospital record | >1 glass/d vs. <=1 glass/d | 0.30(0.13-0.72) | 4 | | - |
| Lan (2010) | Taiwan | 60< | F,M | 725 | 228 | - | | Milk | questionnaire | | Hip fracture | | Hospital record | >=6 vs. <1 time/w | 0.48(0.26-0.89) | 8 | | - |
| 1. **Cross-sectional study** | | | | |  | | | | | | | | | | | | | |
| Wyshak (1989) | US | 21-80 | F | 5398 |  | - | | Low milk diet | Questionnaire | | | Fracture | Questionnaire | Yes vs. no | 1.92(1.15-3.16) | 5 | | 1, 9, 12, 22, 30, 31, 39 |
| 1. **Meta-analysis study** | | | | | | | | | | | | | | | | | | |
| Kanis (2004) | UK | 21-103 | F  M | 27298  12265 | 284  129 |  | | Milk |  | | | Hip fracture |  | High vs. low | 1.09(0.82-1.44)  1.50(0.89-2.54) |  | | - |
| 1-age, 2-clinic, 3-weight, 4-history of osteoporosis, 5-history of fractures since age 50, 6-fall in past 12 months, 7-protein intake, 8-caffeine intake, 9-recreational physical activity, 10-take walks for exercise, 11-impaired low frequency contrast sensitivity, 12-estrogen replacement therapy, 13-thiazide use, 14-calcium supplements, 15-vitamin D supplements, 16-Turns antacid tablets, 17-body height, 18-BMI, 19-diabetes mellitus, 20-disability pension, 21-marital status, 22-smoking, 23-baseline menstrual status, 24-Mediterranean diet score, 25-gender, 26-total energy intake, 27-educational level, 28-history of cardiovascular disease,29- history of cancer, 30 alcohol intake, 31-healthy dietary pattern, 32-ever use of cortisone, 33-Charlson’s comorbidity, 34-country of birth, 35-mental state score, 36-psychotropic drug use, 37-Type of principle occupation as sedentary or housework, 38-Have no telephone, 39-Number of pregnancies, 40-Number of breast feeding babies, 41-Chula ADL index score, 42-Chula Mental Test score, 43-Body appearance, 44-Serum albumin, 45-Serum calcium, 46-Serum phosphate | | | | | | | | | | | | | | | | | | |

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| **Table3. References of included studies.** | | | | | | | |
|  |  | Osteoporosis | | | Hip fracture | | |
|  |  | Meta-analysis | Linear | Dose-response | Meta-analysis | Linear | Dose-response |
| dairy | Cohort | Laird 2017, Matthews 2011,  Shin 2010 | Laird 2017, Matthews 2011,  Shin 2010 | Matthews 2011,  Shin 2010  Hong, 2013, | Sahni 2014, Sahni 2013, Feart 2013, Turner 1999, Michaelsson 2018,  Kanis 2004 | Michaelsson 2018,  Feskanich 2018,  Sahni 2014, Feart 2013, Turner 1999 | Michaelsson 2018,  Feskanich 2018 |
| Case-control/ cross-sectional | Hammad 2017, Lim 2015, AlQuaiz 2014, Wadolowska 2013,  Hong 2013, Grgurevic 2010, Keramat 2008, Woodson 2004 | AlQuaiz 2014, Wadolowska 2013,  Hong, 2013, Keramat 2008 | Kanis 1999, Tavani, 1995, Cumming 1994 | - | - |
| milk | Cohort | Laird 2017, | Laird 2017, | - | Michaelsson 2018,  Feskanich 2018, Sahni 2014, Michaelsson 2014,  Sahni 2013, Feart 2013, Meyer 1997, Fujiwara 1997, Cumming 1997,  Kanis 2004 | Michaelsson 2018,  Feskanich 2018,  Sahni 2014, Michaelsson 2014,  Feart 2013,  Meyer 1997, Fujiwara 1997,  Cumming 1997 | Michaelsson 2018,  Feskanich 2018, Sahni et al. 2014, Michaelson 2014,  Meyer 1997, Fujiwara 1997, Cumming 1997 |
| Case-control/ cross-sectional | Shaw 1993,  AlQuaiz 2014,  Grgurevic 2010, Keramat 2008,  Irvin 2013 | AlQuaiz 2014, Grgurevic 2010,  Keramat 2008 | - | Lan 2010,  Jha 2010, Slavens 2006, Jitapunkul 2001,  Kanis 1999, Tavani 1995, Johnell 1995, Suzuki 1997, Wyshak 1989 | Jha 2010, Slavens 2006,  Tavani 1995 | - |