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Original Contribution

The Association between Obesity and the Prevalence of Low Back Pain in Young Adults

The Cardiovascular Risk in Young Finns Study

Rahman Shiri[1], Svetlana Solovieva[1], Kirsti Husgafvel-Pursiainen[2], Simo Taimela[3], Liisa A. Saarikoski[4], Risto Huupponen[5,6], Jorma Viikari[7], Olli T. Raitakari[4,8], and Eira Viikari-Juntura[1]

[1] Musculoskeletal Disorders Team, Finnish Institute of Occupational Health, Helsinki, Finland.
[2] Biological Mechanisms and Prevention of Work-Related Diseases Team, Finnish Institute of Occupational Health, Helsinki, Finland.
[3] Department of Public Health, University of Helsinki, Helsinki, Finland.
[4] Centre of Applied and Preventive Cardiovascular Medicine, University of Turku, Turku, Finland.
[5] Department of Pharmacology, Drug Development and Therapeutics, University of Turku, Turku, Finland.
[6] Tykslab, Clinical Pharmacology, Hospital District of Southwest Finland, Turku, Finland.
[7] Department of Medicine, University of Turku, Turku, Finland.
[8] Department of Clinical Physiology, University of Turku, Turku, Finland.

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Both low back pain (LBP) and obesity are common public health problems, yet their relation remains controversial. The aim of this study was to investigate the associations between weight-related factors and the prevalence of LBP in young adults in Finland. Participants in the ongoing Cardiovascular Risk in Young Finns Study aged 24–39 years were included ($N = 2,575$). In 2001, 31.2% of men and 39.5% of women reported LBP with recovery within a month or recurrent or continuous pain during the preceding 12 months. For women only, those with higher body mass index, waist circumference, hip circumference, waist-to-hip ratio, serum leptin level, and C-reactive protein level showed an increased prevalence of LBP. With all weight-related factors in the model, only waist circumference was related to LBP in women. For women, the odds ratios of LBP were 1.2 (95% confidence interval: 0.8, 1.8) for a waist circumference of 80–87.9 cm and 1.8 (95% confidence interval: 1.0, 3.2) for a waist circumference of ≥88 cm compared with a waist circumference of <80 cm. This association was independent of C-reactive protein, leptin, and adiponectin levels. The authors' findings in a relatively young population suggest that abdominal obesity may increase the risk of LBP in women.

adiponectin; C-reactive protein; leptin, overweight

Abbreviations: BMI, body mass index; LBP, low back pain.

Low back pain (LBP) is a common health problem (1) that leads to sick leave (2), disability (3), and loss of worker productivity (4). The prevalence of LBP is higher in women than in men (5, 6). Most patients with acute LBP improve within a month (7). Further improvement occurs up to 3 months. However, low level of pain will often persist, and the majority of those affected will have at least one recurrence within a year (7).

Obesity is a worldwide health problem leading to a range of adverse health consequences (8). Previous studies on the

Correspondence to Dr. Rahman Shiri, Musculoskeletal Disorders Team, Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, 00250 Helsinki, Finland (e-mail: rahman.shiri@ttl.fi).

associations between weight-related factors and LBP have yielded inconsistent findings (9). Some have reported an association between obesity and LBP (1, 10, 11), but this association has not been confirmed by others (12, 13). The association between obesity and LBP has been reported to be stronger among women than among men (10, 11, 14, 15).

So far, the mechanisms underlying the association between obesity and LBP are not fully known. Obesity may increase the risk of LBP, for example, because of lumbar disc disorders (16–18), through mechanical load. It has been suggested that mechanical load is the principal factor initiating the degenerative process in the lumbar spine (19). In addition to mechanical load, obesity may cause LBP via low-grade systemic inflammation (16–18, 20, 21). It is well known that adipose tissue is metabolically active and produces adipokines as well as pro- and antiinflammatory cytokines (22). Leptin, in addition to affecting energy balance, stimulates the synthesis of proinflammatory cytokines and nitric oxide; that is, it is directly linked to pain modulation. Moreover, experimental studies on animals suggest that leptin may increase pain sensitivity (23). An association between C-reactive protein—a marker of systemic inflammation—and sciatica has been shown in a few case-control studies (24), whereas studies on the association between C-reactive protein and LBP are sparser (25). It would be particularly valuable to address the association between obesity and LBP in relation to inflammatory factors in a population-based study.

The aim of this study was to investigate the associations between weight-related factors and the prevalence of LBP in a young adult population, taking into account metabolic and inflammatory activities of adipose tissue.

MATERIALS AND METHODS

Population

This study is part of the Cardiovascular Risk in Young Finns Study, an ongoing follow-up study of atherosclerosis risk factors and precursors from childhood to adulthood (26–28). Briefly, children and adolescents aged 3, 6, 9, 12, 15, or 18 years ($N = 4{,}320$) were invited to participate in the first cross-sectional study in 1980; 3,596 (83.2 percent) participated. The study was carried out in five Finnish university cities (Helsinki, Kuopio, Oulu, Tampere, and Turku) and their surrounding municipalities. Equal numbers of men and women were randomly chosen from each center (27). Those subjects who participated in 1980 ($n = 3{,}596$) were invited to later examinations. The follow-up studies were carried out in 1983, 1986, and 2001 in all five centers. A total of 2,991 subjects (83.2 percent) participated in 1983, 2,799 (78.3 percent) in 1986, and 2,620 (76 percent) in 2001.

This study on weight-related factors and LBP was designed as cross-sectional by using data collected in 2001, with historical data on weight-related variables. Questions on LBP were included to explore the association of low back disorders with cardiovascular risk factors. Subjects ($N = 2{,}575$) for whom information on LBP was available in 2001 were included in this study. We excluded pregnant women ($n = 60$) from all analyses except for the prevalence estimate of LBP.

Outcome

The case definition of LBP was created from responses to two separate questions. First, ‘‘Have you had low back trouble (pain, ache, unpleasant sensations) during the preceding 12 months?’’ A manikin was used to denote the anatomic area, and the alternative responses were no and yes. If the answer was yes, a second question was asked regarding tendency and speed of recovery: ‘‘If you had low back trouble during the preceding 12 months, did it subside entirely?’’ The alternative responses were 1) ‘‘Yes, in less than a week’’ (i.e., recovered within a week); 2) ‘‘Yes, in less than a month’’ (i.e., recovered within a month); 3) ‘‘No, I have recurrent low back trouble’’; and 4) ‘‘No, I have continuous low back trouble.’’ In this paper, LBP, ache, and unpleasant sensation are collectively referred to as LBP.

In this study, we used a dichotomous variable of LBP as the outcome. Those who recovered within a month or had recurrent or continuous LBP were compared with those who had no pain or those who recovered within a week. Those with no pain or those who recovered from pain within a week were chosen as the reference group because subjects with LBP who recover quickly are often nonsymptomatic or have mild pain only (29). Moreover, the use of a dichotomous outcome gave us higher power in the study.

Determinants

Weight-related factors in youth. Birth weight was asked via questionnaire in 1983 and was checked by using the well-baby clinics record cards. We grouped birth weight into three levels: low, <2,500 g; normal, 2,500–4,000 g; or high, >4,000 g (30). Age- and gender-specific international cutoff points for body mass index (BMI) (31) were used for 1980 and 1986 data to define overweight and obesity in subjects aged 3–15 years. For subjects aged 18–24 years, BMI was categorized as described in the section below. Subscapular, biceps, and triceps skinfold thickness for 1986 data were divided into three gender-specific, equally sized groups by use of the tertile method.

Weight-related factors in 2001. As part of the health examination, body weight and height and waist and hip circumferences were measured. Weight was measured in light clothes without shoes with a digital scale, with an accuracy of 0.1 kg, and height was measured with a wall-mounted stadiometer with an accuracy of 0.5 cm. BMI was calculated for all subjects (aged 24–36 years), and overweight was defined as 25.0–29.9 kg/m^2, obesity as 30.0–34.9 kg/m^2, and severe obesity as greater than or equal to 35.0 kg/m^2 (32, 33). Waist circumference was classified into one of three groups: <94, 94–101.9, and ≥102 cm for men and <80, 80–87.9, and ≥88.0 cm for women (32, 33). Hip circumference was classified into three gender-specific, equally sized groups by using the tertile method. In addition, the waist-to-hip ratio was computed and was classified into one of three levels: <0.9, 0.9–1.0, and >1.0 for men and <0.8, 0.8–0.9, and >0.9 for women (34).

TABLE 1. Background characteristics of subjects in the Cardiovascular Risk in Young Finns Study, Finland, 2001

Characteristic	Men		Women	
	No.*	Proportion or mean (SD†)	No.*	Proportion or mean (SD)
Age in years (%)				
24	187	16.2	206	15.2
27	176	15.2	230	16.9
30	211	18.2	225	16.6
33	203	17.6	249	18.3
36	206	17.8	243	17.9
39	174	15.0	205	15.1
Socioeconomic status (%)				
Employers and own-account workers	99	10.0	71	5.9
Upper-level white-collar workers	270	27.2	217	18.0
Lower-level white-collar workers	184	18.5	607	50.4
Blue-collar workers	433	43.7	286	23.8
Others	6	0.6	23	1.9
Body mass index (kg/m^2)	1,010	25.7 (4.1)	1,172	24.5 (4.6)
Waist circumference (cm)	979	90.0 (10.9)	1,153	79.3 (11.4)
Hip circumference (cm)	980	100.0 (7.3)	1,149	99.8 (9.1)
C-reactive protein (mg/liter)	1,010	1.5 (3.3)	1,176	2.2 (4.3)
Leptin (ng/ml)	1,008	5.4 (4.3)	1,174	15.4 (10.0)
Adiponectin (μg/ml)	1,009	7.4 (3.3)	1,174	11.0 (4.4)
Smoking (%)				
Nonsmokers	715	63.5	1,001	75.3
Smokers	411	36.5	328	24.7
Leisure-time physical activity (%)				
Once a month or less	330	29.0	304	22.8
Once a week	319	28.0	386	28.9
2–3 times a week	348	30.5	464	34.8
≥4 times a week	143	12.5	180	13.5

* Number of subjects with a measurement.
† SD, standard deviation.

Other determinants in 2001. A self-administered questionnaire elicited information on occupational title, leisure-time physical activity, smoking, and number of deliveries. Radioimmunoassay was used to measure concentrations of serum adiponectin (Human Adiponectin RIA kit; Linco Research, St. Charles, Missouri) and leptin (Human Leptin RIA kit; Linco Research). Plasma high-sensitive C-reactive protein was also measured (35).

Occupational titles were grouped into nine categories by using the classification of socioeconomic status from the Central Statistical Office of Finland (1979) and were further grouped into five categories: employers or own-account workers; upper-level administrative, managerial, and professional workers; lower-level employees with administrative and clerical occupations; manual workers; and others (retired, unemployed, students, voluntary workers). Those who smoked at least once a week or more frequently were classified as smokers. Physical activity was assessed by a single global question: ‘‘How often do you exercise so that you are short of breath or sweating?’’ There were six alternative answers: never, once a month, once a week, two to three times a week, four to six times a week, and daily. The variable was further categorized into four classes: once a month or less (categories 1 and 2), once a week (category 3), two to three times a week (category 4), and at least four times a week (categories 5 and 6). Geographic region was defined as western (Helsinki, Turku, Tampere) or eastern (Kuopio and Oulu) (36).

High sensitive C-reactive protein was dichotomized into two groups, ≤3 mg/liter or >3 mg/liter, according to a recommended cutoff point for high risk of cardiovascular disease (37). Leptin and adiponectin levels were grouped into

TABLE 2. Prevalence of low back pain in men and women during the preceding 12 months, the Cardiovascular Risk in Young Finns Study, Finland, 2001

Low back pain	Men (n = 1,157)		Women (n = 1,418)	
	No.	%	No.	%
None	446	38.6	422	29.8
Recovered within a week	350	30.2	436	30.7
Recovered within a month	103	8.9	154	10.9
Recurrent low back pain	220	19.0	335	23.6
Continuous low back pain	38	3.3	71	5.0

three gender-specific, equally sized levels by use of the tertile method. In addition, for analyses of interaction, we dichotomized leptin and adiponectin at the median level within gender.

Statistical analysis

Logistic regression was used for the multivariable analyses with the aforementioned dichotomous outcome. Subjects' age, socioeconomic status, and smoking (dichotomized) were included in the multivariable models as covariates. Tests for trend (linearity) were conducted with logistic regression by including age or weight-related factors as continuous variables in the models. To assess associations between overweight over time and LBP, we combined data on BMI from different data collection periods and grouped them into five categories, using nonoverweight at all data collection periods as the reference category. Interactions between waist circumference and C-reactive protein, waist circumference and leptin, and waist circumference and adiponectin were investigated by stratification and by logistic regression analysis. In all analyses, the alpha level for statistical significance was set at $p < 0.05$. All analyses were performed by using Stata version 8.2 software (Stata Corporation, College Station, Texas).

RESULTS

Nonresponders to the 2001 survey were somewhat younger than responders (mean age, 31.2 years (standard deviation, 5) vs. 31.5 years (standard deviation, 5), $p = 0.057$). In addition, they were more often men (60.5 percent vs. 44.8 percent, $p < 0.001$). No differences were found regarding geographic region, family income, or BMI in 1980.

We found no major differences in the proportions of men (46 percent) and women (54 percent) or the size of age groups in the study population (table 1). More men than women were manual workers, whereas lower-level white-collar occupations dominated among women. Compared with women, men had higher BMI and waist circumferences but showed no difference in hip circumference. Men had lower levels of C-reactive protein, leptin, and adiponectin and were more often smokers and less physically active.

Table 2 presents the prevalence of LBP by gender. Among the men, 31.2 percent and, among the women, 39.5 percent reported LBP with recovery within a month or recurrent or continuous pain during the preceding 12 months. There was an increase in LBP with age among men (p for trend <0.0001) but not among women (p for trend = 0.11) (figure 1).

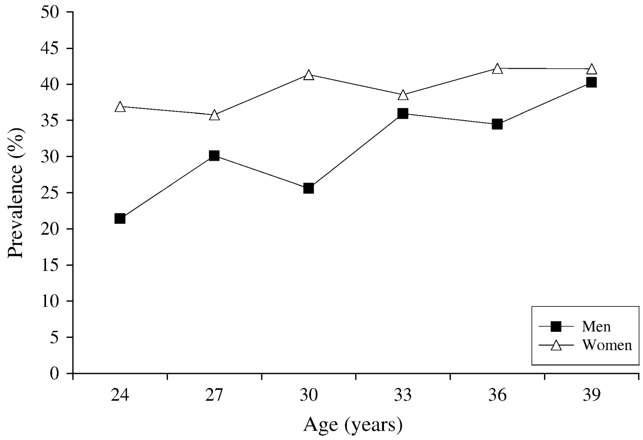

FIGURE 1. Prevalence of low back pain with recovery within a month or recurrent or continuous pain during the preceding 12 months, by age and gender, the Cardiovascular Risk in Young Finns Study, Finland, 2001. The difference in the prevalence of low back pain between men and women was statistically significant at ages 24 and 30 years only.

Weight-related factors

Current (measured in 2001) BMI, waist circumference, hip circumference, and waist-to-hip ratio were associated with LBP with recovery within a month or recurrent or continuous pain during the preceding 12 months for women only (table 3). The associations were statistically significant for only those with a BMI of $\geq$35.0 kg/m^2, with a waist circumference of $\geq$88.0 cm, in the third tertile of hip circumference, or with a waist-to-hip ratio of >0.9. With all weight-related parameters in the model, only that association between waist circumference and LBP remained statistically significant (table 4).

The association between waist circumference and LBP was modified by age (figure 2). Women in the age groups 24 and 27 years whose waist circumference was $\geq$80 cm had a higher prevalence of LBP compared with those whose waist circumference was <80 cm ($p = 0.004$). For women aged 30 years ($n = 190$), the prevalence of LBP was high among only those ($n = 37$) whose waist circumference was $\geq$88 cm ($p < 0.001$). An increased prevalence of LBP among those whose waist circumference was $\geq$88 cm was independent of history of delivery (adjusted odds ratio = 1.8, 95 percent confidence interval: 1.1, 3.1 for subjects with no history of delivery and odds ratio = 1.8, 95 percent confidence interval: 1.2, 2.7 for subjects with a history of delivery). The marked increase in the prevalence of LBP

TABLE 3. Sex-specific, adjusted odds ratios of low back pain,* by current (2001) and youth (1980 and 1986) weight-related factors (N = 1,429–2,137), the Cardiovascular Risk in Young Finns Study, Finland

Characteristic	Men					Women				
	No.	No. of cases	OR†,‡	95% CI†	p for trend	No.	No. of cases	OR‡	95% CI	p for trend
Weight-related factors in 2001										
Body mass index (kg/m^2)										
<25.0	481	158	1			759	272	1		
25.0–29.9	397	121	0.8	0.6, 1.1		280	116	1.2	0.8, 1.6	
30.0–34.9	104	36	0.9	0.5, 1.4		92	43	1.4	0.9, 2.3	
≥35.0	28	8	0.5	0.2, 1.4	0.11	41	26	3.1	1.5, 6.5	0.002
Waist circumference (cm)										
<94.0	664	211	1							
94.0–101.9	174	59	1.1	0.7, 1.6						
≥102.0	141	41	0.7	0.4, 1.1	0.16					
Waist circumference (cm)										
<80.0						701	243	1		
80.0–87.9						222	92	1.3	0.9, 1.8	
≥88.0						230	117	1.8	1.3, 2.4	<0.001
Hip circumference (tertile)										
First	285	90	1			350	122	1		
Second	362	128	1.3	0.9, 1.9		399	140	1.0	0.7, 1.4	
Third	333	94	1.0	0.6, 1.4	0.85	400	188	1.6	1.1, 2.1	0.005
Waist-to-hip ratio										
<0.9	522	156	1							
0.9–1.0	406	138	0.9	0.6, 1.3						
>1.0	51	17	0.9	0.5, 1.8	0.60					
Waist-to-hip ratio										
<0.8						680	246	1		
0.8–0.9						396	162	1.2	0.8, 1.5	
>0.9						73	42	2.3	1.3, 3.9	0.009
Leptin (tertile)										
First	320	98	1			391	126	1		
Second	338	120	1.4	0.9, 2.0		390	158	1.5	1.1, 2.0	
Third	350	101	0.9	0.6, 1.3	0.53	393	174	1.6	1.2, 2.2	0.003
Adiponectin (tertile)										
First (lowest)	332	109	1			385	162	1		
Second	333	97	0.8	0.6, 1.2		394	153	0.9	0.6, 1.2	
Third (highest)	344	113	1.1	0.7, 1.5	0.71	395	143	0.8	0.6, 1.1	0.11
High-sensitive C-reactive protein										
≤3	911	285	1			969	362	1		
>3	99	35	1.0	0.6, 1.7	0.98	207	96	1.4	1.0, 2.0	0.027

Table continues

was also seen among obese women aged 30 years when waist-to-hip ratio or BMI was used as an indicator of obesity (data not shown). For men, no statistically significant associations were found between waist circumference and LBP in any age group.

Men who had been overweight in youth (1980 and 1986) had a lower prevalence of LBP compared with non-overweight subjects, while there was an opposite trend for women. The risk estimates for overweight and obesity in women showed a dose-response pattern, although it

TABLE 3. Continued

Characteristic	Men					Women				
	No.	No. of cases	OR‡	95% CI	*p* for trend	No.	No. of cases	OR‡	95% CI	*p* for trend
Weight-related factors in youth										
Birth weight (g)										
<2,500	37	7	0.6	0.2, 1.4		42	16	1.1	0.5, 2.1	
2,500–4,000	415	129	1			597	238	1		
>4,000	516	157	1.1	0.8, 1.5	0.46	501	208	1.0	0.8, 1.4	0.76
Body mass index in 1980										
Normal	1,047	336	1			1,245	478	1		
Overweight	82	16	0.5	0.2, 0.9		93	41	1.2	0.7, 1.9	
Obese	18	7	1.0	0.3, 3.1	0.08	14	8	2.4	0.7, 7.6	0.11
Body mass index in 1986										
Normal	761	236	1			907	355	1		
Overweight	95	22	0.6	0.3, 0.99		105	44	1.1	0.7, 1.7	
Obese	18	5	0.3	0.1, 1.4	0.01	17	11	2.4	0.8, 6.7	0.17
Subscapular skinfold thickness in 1986 (tertile)										
First	270	72	1			338	120	1		
Second	299	92	0.9	0.6, 1.5		338	145	1.2	0.8, 1.7	
Third	306	99	0.9	0.5, 1.4	0.51	349	142	1.0	0.7, 1.5	0.95
Biceps skinfold thickness in 1986 (tertile)										
First	283	87	1			335	125	1		
Second	310	100	1.1	0.8, 1.7		339	141	1.2	0.8, 1.7	
Third	282	76	0.8	0.5, 1.3	0.44	355	144	1.1	0.7, 1.5	0.74
Triceps skinfold thickness in 1986 (tertile)										
First	291	85	1			341	128	1		
Second	297	102	1.2	0.8, 1.7		338	141	1.1	0.8, 1.6	
Third	283	74	0.8	0.5, 1.2	0.32	350	141	1.0	0.7, 1.4	0.80
2001 and youth body mass index										
Normal weight in 1980, 1986, and 2001	367	123	1			555	205	1		
Overweight only in 1980 and/or 1986	12	2	0.5	0.1, 2.5		26	8	0.9	0.4, 2.2	
Overweight only in 2001	284	85	0.8	0.5, 1.1		217	92	1.1	0.7, 1.5	
Overweight in 1980 or 1986 and 2001	69	19	0.6	0.3, 1.1		66	30	1.3	0.7, 2.3	
Overweight in 1980 and 1986 and 2001	38	7	0.2	0.1, 0.7	0.004	37	21	1.7	0.8, 3.5	0.15

* Subjects who recovered within a month or had recurrent or continuous low back pain during the preceding 12 months compared with those with no pain or who recovered within a week.

† OR, odds ratio; CI, confidence interval.

‡ Adjusted for age, socioeconomic status, and smoking.

was not statistically significant. Birth weight or subscapular, biceps, or triceps skinfold thickness measures in 1986 were not associated with LBP in either gender (table 3).

Compared with subjects whose BMI was normal in 1980, 1986, and 2001, women who were overweight in all three surveys had a marginally increased prevalence of LBP. However, overweight men had a lower prevalence of LBP (table 3).

Waist circumference and leptin and adiponectin levels

Leptin concentration correlated highly with waist circumference in both men and women (correlation coefficient =

TABLE 4. Sex-specific, adjusted odds ratios of low back pain,* by all weight-related factors in the model, the Cardiovascular Risk in Young Finns Study, Finland, 2001

Weight-related factor	Men			Women		
	OR†,‡	95% CI†	*p* for trend	OR‡	95% CI	*p* for trend
Body mass index (kg/m^2)						
<25.0	1			1		
25.0–29.9	0.7	0.4, 1.1		0.7	0.4, 1.2	
≥30.0	0.8	0.3, 1.9	0.27	0.9	0.4, 1.7	0.65
Waist circumference (cm)						
<94.0	1					
94.0–101.9	1.1	0.6, 1.7				
≥102.0	0.7	0.4, 1.7	0.49			
Waist circumference (cm)						
<80.0				1		
80.0–87.9				1.2	0.8, 1.8	
≥88.0				1.8	1.0, 3.2	0.05
Hip circumference (tertile)						
First	1			1		
Second	1.5	0.9, 2.2		1.0	0.7, 1.3	
Third	1.4	0.7, 2.4	0.19	1.3	0.8, 2.0	0.43

* Subjects who recovered within a month or had recurrent or continuous low back pain during the preceding 12 months compared with those with no pain or who recovered within a week.

† OR, odds ratio; CI, confidence interval.

‡ Adjusted for age, socioeconomic status, smoking, and each other.

0.73, $p < 0.001$ for men and correlation coefficient = 0.71, $p < 0.001$ for women). As expected, adiponectin level decreased with an increase in waist circumference (correlation coefficient = −0.24, $p < 0.001$ for men and correlation coefficient = −0.34, $p < 0.001$ for women). The prevalence of LBP increased with increasing serum leptin level in women (table 3). Adiponectin was not associated with LBP in either gender. The association between waist circumference and LBP was independent of leptin level (table 5).

We found no interaction between waist circumference and adiponectin level in relation to LBP.

Waist circumference and C-reactive protein

C-reactive protein was associated with LBP in women only (table 3). C-reactive protein level and waist circumference were associated in both men and women ($p <$ 0.001 for both). Separate and joint effects of waist circumference and C-reactive protein on LBP are shown in table 5. For women, the association between waist circumference and LBP was independent of C-reactive protein. For women with a normal waist circumference, high C-reactive protein was related to increased prevalence of LBP (odds ratio = 1.5); however, the estimate was not statistically significant.

DISCUSSION

We studied several weight-related factors, adipokines, and the inflammatory marker C-reactive protein in relation to LBP in a representative young population sample. Our findings showed that obesity is associated with LBP in women but not in men. Of weight-related factors, waist circumference was the strongest determinant of LBP in women. This association was independent of C-reactive protein, leptin, and adiponectin levels.

In line with earlier studies, women had a higher prevalence of LBP compared with men (5, 6). We found this difference to be largest in the youngest age group and to diminish toward middle age. Other studies have reported a steeper increase in LBP for girls than boys already in puberty, and it has been associated with hormonal changes, irregular or prolonged menstrual cycle, and different pain perception and recall of symptoms (38–40).

Waist circumference and BMI measure different aspects of obesity. Waist circumference is a strong predictor of both visceral and subcutaneous adipose tissues (41). Thus, waist circumference is a better measure of abdominal obesity; BMI captures body fat as well as lean body mass and does not reflect distribution of body fat (42). Leptin, an adipokine produced by adipose tissue, was strongly associated with waist circumference but did not add to the risk of LBP for those with a large waist circumference. Adiponectin, another adipokine, was not related to LBP. In agreement with another population-based study (43), our findings suggest that abdominal obesity is the primary weight-related risk factor for LBP. Obesity may exert its effects on LBP via mechanical stress, metabolic or inflammatory pathways, or their interplay.

We found abdominal obesity to be associated with LBP in women. Those with a large waist circumference had a higher prevalence of LBP in most but not all age groups. This finding could be due to changes in the proportions of visceral and subcutaneous fat at different ages. It can also be due to fluctuation in data or unmeasured confounding. Abdominal obesity was not associated with LBP in men.

The associations between BMI and LBP differed between men and women. Persistent overweight was associated with a lower prevalence of LBP in men, but no association was found for women. The gender-related differences in the association of overweight or obesity defined by BMI with LBP could be related to the differences in the distribution of body fat mass or to the proportion of lean body mass, known to be larger in younger people (42) than in older people. The lower prevalence of LBP in young men with a high BMI in our study may be due to increased muscle mass. In fact, extremely high BMI has been associated with LBP in men in other studies (44). Our sample size was too small to study the effects of persistent obesity in men. In all, the capacity of BMI to reflect adiposity harmful to the health of the low back may be limited in the same way as has been observed for other health outcomes (42).

In agreement with earlier findings (34), we found an increase in C-reactive protein level with increasing waist circumference in both genders. The association between C-reactive protein and LBP was moderate and became nonsignificant after controlling for waist circumference. Adipose tissue produces several proinflammatory cytokines (e.g., tumor necrosis factor-α, interleukin-6) that increase the release of C-reactive protein. C-reactive protein is, however, stimulated by a variety of determinants (45) and is therefore a nonspecific marker of inflammatory effects of adipose tissue. Moreover, subjects with LBP may have different types of pain—for example, sciatic pain, lumbago—and some types may have a stronger inflammatory component than others. In an additional analysis (data not shown), we used the original LBP question to compare the distributions of speed of recovery. Women with a normal waist circumference and high C-reactive protein level tended to more often report continuous LBP than those with low C-reactive protein levels, suggesting different underlying pathology.

Characterization of LBP includes frequency, intensity, and duration of pain and associated loss of productivity and disability, with fluctuations over time (29). With data on recovery and chronicity but not on severity of LBP, our aim was to address clinically significant LBP. Therefore, we included in the reference category subjects with LBP who recovered within a week. Additional analyses with only nonsymptomatic subjects in the reference category produced similar findings (data not shown).

We adjusted the obtained odds ratios for common known risk factors for LBP, for example, socioeconomic status, occupational class, and smoking. Leisure-time physical activity was not associated with weight-related factors or LBP and therefore was not adjusted for in the analysis. The observed associations in our study are less likely due to confounding by these factors. However, the observed associations may have been affected by psychological and psychosocial factors (5).

In summary, we found current or persistent obesity, and especially abdominal obesity, to be associated with LBP in relatively young women but not in men. The studied indicators of adipose tissue activity did not add to the effects of abdominal adiposity. Future analyses focusing on relations between LBP and weight-related factors, known risk factors for atherosclerosis, and gene-environment interactions in a population of relatively young adults with a smaller burden of other age-related diseases, such as the present material, would be valuable in widening our understanding of underlying etiologies and mechanisms.

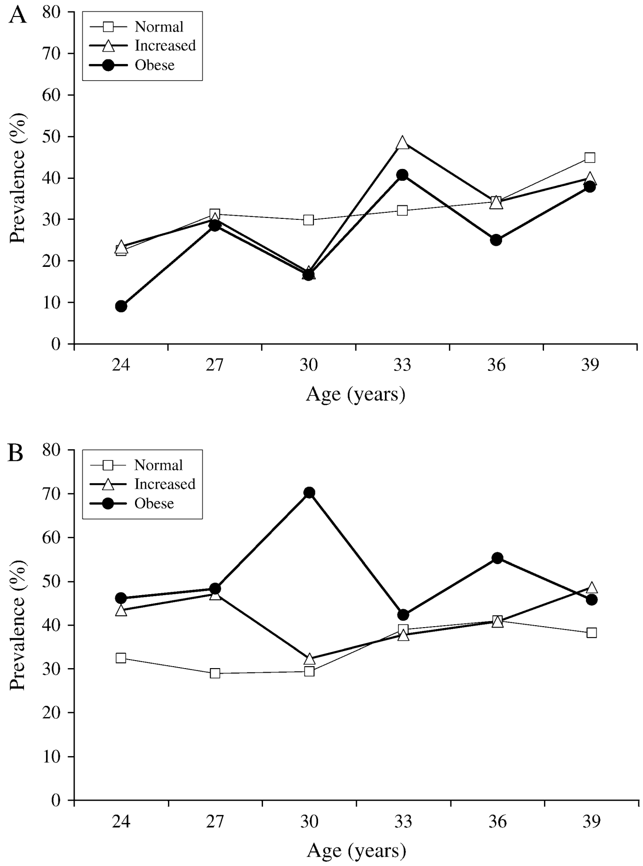

FIGURE 2. Prevalence of low back pain with recovery within a month or recurrent or continuous pain during the preceding 12 months, by age, gender (A, men; B, women), and waist circumference, the Cardiovascular Risk in Young Finns Study, Finland, 2001. Pregnant women ($n = 60$) were excluded. Normal, waist circumference <94 cm for men and <80 cm for women; increased, waist circumference 94–101.9 cm for men and 80–87.9 cm for women; obese, waist circumference ≥102 cm for men and ≥88 cm for women.

TABLE 5. Separate and joint effects of increased waist circumference and leptin (dichotomized at the median level within gender) and increased waist circumference and C-reactive protein on low back pain,* the Cardiovascular Risk in Young Finns Study, Finland, 2001

	Waist circumference†	Men				Women			
		No.	No. of cases	OR‡,§	95% CI‡	No.	No. of cases	OR§	95% CI
Leptin level									
Low	Normal	348	142	1		492	167	1	
High	Normal	211	65	1.1	0.7, 1.6	204	75	1.2	0.8, 1.8
Low	Increased or obese	35	16	1.4	0.7, 3.0	81	37	1.7	1.0, 2.9
High	Increased or obese	278	83	0.8	0.6, 1.2	371	172	1.6	1.2, 2.1
C-reactive protein level									
Low	Normal	620	194	1		626	212	1	
High	Normal	40	14	0.9	0.4, 2.1	72	30	1.5	0.9, 2.6
Low	Increased	151	50	1.1	0.6, 1.7	180	74	1.3	0.9, 1.9
High	Increased	22	8	0.9	0.3, 2.7	42	18	1.3	0.6, 2.6
Low	Obese	108	30	0.6	0.3, 1.1	141	72	1.8	1.1, 2.7
High	Obese	33	11	0.9	0.4, 2.1	89	45	1.8	1.0, 3.0

* Subjects who recovered within a month or had recurrent or continuous low back pain during the preceding 12 months compared with those with no pain or who recovered within a week.

† Normal, waist circumference <94 cm for men and <80 cm for women; increased, waist circumference 94–101.9 cm for men and 80–87.9 cm for women; obese, waist circumference ≥102 cm for men and ≥88 cm for women.

‡ OR, odds ratio; CI, confidence interval.

§ Adjusted for age, socioeconomic status, and smoking. Separate and joint effects of increased waist circumference and C-reactive protein were also adjusted for leptin level.

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