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Active or passive journeys and low back pain in adolescents

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Abstract The objective of this cross-sectional study was to study associations between low back pain (LBP) and modes of transport to school and leisure activities among adolescents. The study population included all adolescents in eighth and ninth grade in two geographic areas in eastern Norway. Eighty-eight adolescents participated (mean age 14.7 years), making the response rate 84%. Data concerning active (walking/bicycling) and passive (bus/car) journeys were obtained from lists and maps from local authorities, and from the pupils, using a questionnaire that also included LBP, activities and wellbeing. Distance walked/bicycled

to school was slightly shorter among those reporting LBP in bivariate analyses. Walking/bicycling more than 8 km weekly to regular activities was inversely associated with LBP in multivariate analysis (OR 0.3; 95% confidence interval 0.1–1.0). No associations were found between passive journeys and LBP. The results raise the question for future research of whether lack of active transport may be one cause behind the increase in juvenile LBP.

Keywords Adolescents · Walking · Bicycling · Low back pain · Bus · Vibration

Introduction

The aetiology behind the high and increasing level of low back pain (LBP) in the Western world is still mostly unclear [1, 7]. Potential risk factors are lower social class, lower level of education, heavy physical work, frequent bending and twisting, lifting, static work postures, psychological distress, low work satisfaction and whole body vibrations (WBV), mainly defined as occupational driving [1, 4, 9]. A cross-cultural review indicated lower levels of LBP in non-industrialised regions; two of several suggested explanations were less driving and more physical exercise in daily life in these regions [29].

LBP is also common in children and adolescents, with a lifetime prevalence estimated at 30–50% [2]. There are few prospective studies. Potential risk factors are increasing age, female gender, family history of LBP, high level of physical activity, competitive sport, long periods spent

watching television and sitting, psychological distress, smoking and manual work [2, 6].

It has been postulated that walking may prevent LBP [13, 22]. British and Norwegian surveys report a reduction in walking to work and school between 1985 and 1992 [5, 25]; some of the reasons may be long distances and lack of safe roads for walking or bicycling (pedestrian routes). Travel to school and to leisure activities may be categorised into active journeys (walking or bicycling) and passive journeys (sitting in a bus or a car). School bus journeys are free in Norway for pupils in compulsory school when the distance between school and home is above 4 km, and for shorter distances when the school journey is considered to be dangerous. The age limit is 18 years for a driving licence in Norway.

Our recent cross-sectional studies indicate inverse associations between passive school journeys and hip mobility in adolescents, and positive associations between walking or bicycling to leisure activities, hip mobility and

1. How long is your school journey one way?km
2. How long time does the journey from home to school?min.
3. How do you usually travel to school ? 1 ☐ Walking 2 ☐ Bicycling 3 ☐ School bus 4 ☐ Private car
4. For those using school bus:
 - 4.1 What is the distance from home to the bus stop?km.
 - 4.2 How do you usually get from home to the bus stop?
1 ☐ Walking 2 ☐ Bicycling 3 ☐ Private car
 - 4.3. How long time does the bus journey take one way to school?min
5. How many hours do you usually spend weekly on television and computer, video and computer games included?hours
6. How many hours do you usually spend reading, lessons included?hours
7. How many times weekly do you usually engage in planned leisure physical activity, including bicycling and tracking (at least 45 min. duration)?
1 ☐ None 2 ☐ 1-2 3 ☐ 3-4 4 ☐ 5 or more
8. How many times weekly do you usually engage in planned non-physical activity (at least 45 min. duration)?
1 ☐ None 2 ☐ 1-2 3 ☐ 3-4 4 ☐ 5 or more

9. ACTIVITIES AND JOURNEYS. INCLUDE ACTIVITIES PERFORMED AT LEAST FOR THE LAST TWO MONTHS AND PREVIOUS ACTIVITIES, STOPPED WITHIN THE LAST 2 MONTHS, PERFORMED FOR AT LEAST 6 MONTHS.

ACTIVITY TYPE	TIMES WEEKLY	TIME USE WEEKLY	DISTANCE HOME – ACTIVITY km	USUAL WAY OF TRANSPORT Drive Walk/cycle Both	TIME SPENT TRANSPORT ONE WAY Minutes	SPORT COMPETITION	
		Hours				Yes	No
Football							
Handball							
Aerobics/gymnastics							
Skiing/slalom							
Skating							
Swimming							
Jogging							
Forest tracking							
Horse-riding							
Other physical Activity: Describe							
Handwork, carpentry							
Scouting							
Active music							
Other non-physical Activity: Describe							

10. How often do you perform physical work like snow clearing, washing floors, heavy farm work (at least 45 min duration)?
1 ☐ Daily 2 ☐ Weekly 3 ☐ Monthly 4 ☐ Some times a year 5 ☐ Never
11. How often do you participate in driving a tractor or a scooter (at least 45 min duration)?
1 ☐ Daily 2 ☐ Weekly 3 ☐ Monthly 4 ☐ Some times a year 5 ☐ Never
12. Do you mostly feel strong and fit, or tired and worn out:
1 ☐ Very strong and fit 2 ☐ Strong and fit 3 ☐ Quite strong and fit 4 ☐ Both fit and tired
5 ☐ Quite tired and worn out 6 ☐ Tired and worn out 7 ☐ Very tired and worn out.
13. Would you say you are usually cheerful or dejected?
1 ☐ Very dejected 2 ☐ Dejected 3 ☐ Quite dejected 4 ☐ Both depressed and cheerful
5 ☐ Quite cheerful 6 ☐ Cheerful 7 ☐ Very cheerful
14. Do you by and large feel calm and good about yourself?
1 ☐ Almost all the time 2 ☐ Often 3 ☐ Seldom 4 ☐ Never

Fig. 1 Questionnaire: daily life

Fig. 2 Questionnaire: low back pain

Low back

1a. Have you ever had any trauma to your low back?	Yes ☐ No ☐
1b. If so, did you recover completely after the trauma?	Yes ☐ No ☐
2. Have you ever had LBP (pain, aching, discomfort) in the low back, not connected to trauma and menstrual pain?	Yes ☐ No ☐
3. Have you ever been investigated or treated by a professional for LBP?	Yes ☐ No ☐
4. Have you had LBP during the last year?	Yes ☐ No ☐
The confirming responders to question no 4 continue to no 5:	
5. For how many days have you suffered from LBP last year:	
a) 1-7 days ☐	b) 8-30 days ☐
c) More than 30 days, but not everyday ☐	d) Everyday ☐
6. Has low back pain caused you to change your activities in the last twelve months?	Yes ☐ No ☐
7. Have you been seen by a doctor, physiotherapist, chiropractor or other such person due to low back pain during the last 12 months?	Yes ☐ No ☐
8. Have you ever taken an X-ray-examination of your low back?	Yes ☐ No ☐
9. Do the following activities/positions initiate/increase low back pain:	
a) Sitting at school on ordinary school days	Yes ☐ No ☐
b) Sitting at home doing lessons	Yes ☐ No ☐
c) Watching television at home	Yes ☐ No ☐
d) Sitting in car or bus to school	Yes ☐ No ☐
e) Sitting in car or bus in leisure time	Yes ☐ No ☐
f) Other sitting positions	Yes ☐ No ☐
g) Manual work in forward bending positions (housecleaning, gardening, mechanical work etc.) lasting 45 min-one hour	Yes ☐ No ☐
h) Gym classes at school	Yes ☐ No ☐
i) Leisure physical activities: Football ☐ Handball ☐ Skiing ☐ Skating ☐ Snowmobile ☐	
j) Other activities	
.....	

Questionnaire of low back pain

low back strength [19], while no associations were found between social class or parental LBP and juvenile LBP [20]. The objective of the present study was to investigate whether transport modes to school and leisure activities were associated with LBP in the same population. It was hypothesised that LBP would be associated inversely with active journeys, and positively with passive journeys.

Materials and methods

Methods

Design

In this cross-sectional study data were collected by maps and lists from community authorities and the teachers, and by questionnaires answered by the adolescents and their parents.

Implementation of the study

Written consent was obtained from the regional ethical committee, the adolescents and the parents in 1996. The parents' questionnaire was answered by post during autumn 1996. The questionnaire (Fig. 1, Fig. 2) for the adolescents was answered in January 1997 in the classrooms in the presence of a teacher and the author.

Material

Inclusion criteria were all pupils in eight and ninth grade who had lived for at least 3 years at the same address in either of two contrasting environments as regards school journeys:

1. A rural municipality, Rendalen ($n=44$). All adolescents in Rendalen were pupils at Fagertun combined primary and junior secondary school, where most pupils used the school bus, due to school centralisation and lack of pedestrian routes, according to the school authorities.
2. A nearby suburban area, Hanstad in Elverum municipality, extending 4 km from Hanstad combined primary and junior secondary school ($n=61$) in all directions. The adolescents had no access to free school buses due to the 4-km limit and a net of pedestrian routes between the school and the residential areas.

The headmasters and teachers at both schools who lived in the designated areas confirmed that all the adolescents in the study population usually walked or bicycled to the school bus stop or to school.

The exclusion criterion was serious disease; none were excluded. A total of 38 girls and 50 boys participated, making the response rate 84%. Mean age was 14.7 years (SD 0.7, range 14.1–16.1 years). The response rate and the gender distribution were similar in the two areas.

Measurements

Dependent variable

LBP was assessed by a questionnaire adapted from two Nordic questionnaires [12, 18], which included a drawing of the low back. LBP was defined as aching, pain or discomfort in the low back during the preceding year, not related to trauma or menstrual pain.

Independent variables

The pupils' addresses and lengths of the school bus journeys in primary and junior secondary school were obtained from lists provided by the school authorities. Active school journeys and active and passive journeys to regular activities were calculated by mea-

suring the distances on maps obtained from the community authorities. The distances were cross-checked with lists from the teachers and information given by the pupils in the questionnaire.

Control variables

The questionnaire for the adolescents included items on weekly regular leisure activities performed, Monday to Friday, for at least 2 months, and time spent in front of a television or computer [16]. Social class and parental LBP were registered by a questionnaire answered by 87% of the fathers and 91% of the mothers. Social class was measured as parental occupation, and classified into seven categories according to a Norwegian standard [14]. Parental LBP was defined as treatment or visit to a health professional due to LBP during the preceding year among any of the parents. Well-being was measured by three questions concerning cheerfulness, fitness and calmness, used in Norwegian health surveys, tested for reliability and for validity against the Hopkins Symptom Checklist [23]. An index, ranging from 3 to 18, was made of the questions (Cronbach's alpha 0.8).

A test-retest of the questions constructed for the study on a subsample of ten adolescents showed a correlation coefficient of $r=0.7$ for manual work and time spent in front of a television/computer, and $r=0.9$ for amount of time spent in and frequency of physical activity. The Kappa coefficient was 0.57 for the latter, and 0.44 for quartiles of time in front of television or computer.

Statistical analyses

All school journeys were multiplied by ten, to calculate the total distances covered Monday to Friday. Associations were estimated by Chi-square tests, Student's t -tests, Mann-Whitney tests, Pearson's correlation (r), and ordinal logistic regression analyses, ordering LBP last year into three levels: (1) No LBP, (2) LBP 1–30 days, (3) LBP 31 days–daily. The interpretation of ordinal logistic regression is the same as in binary logistic regression analyses. All levels of the variables were generally utilised in the regression analyses, except time spent in front of a television/computer, in which quartiles were used. The level of significance was set to $P \leq 0.05$, and is marked in *bold type* in the tables. The programme used was Minitab, version 13.2.

Results

Journeys to school and activities

The school bus was used by 89% of the rural pupils in primary school and by 94% in junior secondary school. Me-

Table 1 Journeys (km) to school and to regular activities (Monday–Friday) among 88 school children, by area

	Rural area $n=38$		Urban area $n=50$		P -value ^a
	Median	Range	Median	Range	
Primary school					
Walking/bicycling to school/bus stop	2.0	0.1–35	6.0	4–40	<0.0005
School bus	65	0–320	0	0	
Junior secondary school					
Walking/bicycling to school/ bus stop	2.0	0.1–25	5.5	4–40	<0.0005
School bus	120	0–470	0	0	
Walking/bicycling to activities	0	0–10	5.3	0–48	<0.0005
Car or bus to activities	12	0–150	1.5	0–100	0.2

^a Mann-Whitney test

dian time spent weekly on the school bus in junior secondary school pupils was approximately 3.5 h among the rural adolescents. All pupils at both school levels reported that they usually walked or bicycled from home to school or to the bus stop. Active and passive journeys to school and regular leisure activities are shown in Table 1.

The median weekly active journey for pupils in the rural areas was 2.0 km for both primary and junior secondary school students. In the urban area it was 6.0 km for those at primary school and 5.5 km for junior secondary pupils. The median weekly distance walked or bicycled to activities was 0 km in the rural area and 5.3 km in the urban area ($P<0.0005$), while the median distance travelled by car or bus to activities was 12 km and 1.5 km, respectively ($P=0.2$).

Active school journeys in primary and junior secondary school were highly correlated ($r=0.86$), as well as school bus distances in primary school and junior secondary school ($r=0.77$). Active journeys to primary and junior secondary school were modestly correlated with active journeys to activities ($r=0.3$; $P=0.005$ and 0.001 , respectively). There were slight inverse correlations between active and passive journeys to primary school ($r=-0.29$; $P=0.006$) and to junior secondary school ($r=-0.24$; $P=0.03$).

Control variables

Median weekly time spent on leisure physical activity and television/computer was 7 and 15 h, respectively, with minor, insignificant gender and geographical differences. Median score on the wellbeing index was 13, mean 12.7, and range 6–18. A transformation of the seven categories of parental occupation to three categories showed that 48% of the parents were classified in the lower social class, 26% in the middle class and 27% in the upper class. Twenty-three percent of the parents reported receiving treatment for LBP during the preceding year.

LBP

Lifetime prevalence of LBP was 62% and 68% in the urban and rural areas, respectively, and LBP during the preceding year was reported by 54% and 61% of the urban and rural study populations respectively. Seventy-one percent of the girls and 46% of the boys reported LBP during the preceding year, and 7% had been treated for LBP. Seventeen percent of pupils using the school bus reported LBP during the bus journey. LBP provoked by car or bus was reported by 24% of rural adolescents and 10% of urban adolescents ($P=0.08$).

LBP and journeys

Associations between LBP and journeys are displayed in Table 2, and in a boxplot (Fig. 3).

There were weak associations between LBP and short active journeys to primary school and junior secondary school. The median weekly distance walked or bicycled to activities was 0.5 km among those reporting LBP and 2.1 km among those reporting no LBP ($P=0.2$).

Adolescents with an active school journey exceeding 5 km (median) reported LBP less frequently than those with a shorter journey at both school levels: 30% versus 55% ($P=0.02$) in primary school and 36% versus 55% in junior secondary school ($P=0.005$). There was a trend towards an inverse association between walking/bicycling 8 km or more to activities (upper quartile border) and LBP ($P=0.08$), but not for the median value of 1 km.

There were fairly similar median values for the length of school journeys among girls with and those without LBP, while boys reporting LBP walked or bicycled 5 km compared to 7 km among boys reporting no LBP, both in junior secondary school. Median values for the distance of active journeys to activities for girls with and without LBP were 1 km and 4 km, respectively. Corresponding figures for boys with and without LBP were 0 and 1.5 km. There was a tendency towards an association between bus journeys exceeding 32 km and reports of LBP during the journey ($P=0.07$).

Table 2 Associations between low back pain (LBP) and journeys (km) to school and to regular activities (Monday–Friday) among 88 school children

	LBP+		LBP–		<i>P</i> -value ^a
	Median	Range	Median	Range	
Primary school					
Walking/bicycling to school/bus stop	5.0	0.2–30	6.3	0.1–40	0.02
School bus	0	0–320	0	0–320	0.6
Junior secondary school					
Walking/bicycling to school/bus stop	5.0	0.2–25	6.3	0.1–40	0.01
School bus	0	0–470	0	0–470	0.6
Walking/bicycling to activities	0.5	0–35	2.1	0–48	0.2
Car or bus to activities	6.0	0–100	1.5	0–150	0.9

^a Mann-Whitney's test

Fig. 3 Walking/bicycling to activities Monday to Friday, and LBP

Ordinal multiple regression analyses were performed in three models, displayed in Table 3.

The first model adjusted the independent variables for gender. In the second model the independent variables were in addition adjusted for each other. The third model also adjusted for physical activity, time spent in front of a television/computer and wellbeing, as these factors were associated with LBP, in contrast to social class and parental LBP, which were not. There were tendencies to inverse associations between active school journeys and LBP in the gender-adjusted models. Active journeys to activities were inversely associated with LBP in all three models. No significant associations were found between passive journeys and LBP.

A replacement of the value for weekly length of active journey to activities with a dichotomous variable with a cut-off at 8 km or more (upper quartile) in the third regression equation showed an odds ratio (OR) of 0.3 (95% CI 0.1–1.0; $P=0.05$). Binary multiple logistic regression analyses, adjusting for the same factors, showed a similar trend (OR=0.4, 95% CI 0.1–1.3; $P=0.1$).

Discussion

The hypothesis of an inverse association between regular walking or bicycling and LBP was partially supported, as the active journey to activities predicted less LBP in all regression models. However, the small difference of 1.6 km weekly walked or bicycled to activities seems too small for possible biological effects. Short active school journeys were associated with LBP in bivariate analyses, but the difference of 1.3 km weekly is also far too small for producing health effects. The small differences may imply that the results are statistical coincidences, and the results need to be confirmed in larger samples and prospective studies.

Another explanation of the findings, however, may be that the active journey to activities reflects other regular and irregular active journeys in daily life, performed possibly during the weekend, and does so better than the active school journey. This explanation is validated by findings in our previous study, in which physical performance was more strongly associated with active journey to activities than with active journey to school [19]. One hypothesis, derived from Rose [17] and Volinn [29], is that the distances of the active journeys may be far too short to show considerable effects on the outcome, as walking or bicycling as much as 8 km or more to activities (upper quartile) only reduced the risk of LBP by 40% according to Table 3 ($0.94^8=0.6$). The alternative regression analysis, dichotomising the active transport at the same level, reduced the risk to 0.3. The box plot suggests a similar trend.

The results support Belgian findings, in cross-sectional and prospective studies, of less LBP in children walking to school compared to those brought to school by car or public transport [8, 22]. However, they contrast with a French study, in which long walking distance to school was associated with LBP; the latter association was only valid, however, for pupils carrying school bags exceeding 20% of their weight [28]. Walking has also been described as a pain-relieving activity among adults suffering from

Table 3 Associations between LBP and journeys (km) to school and regular activities (Monday–Friday). Results of ordinal logistic regression analyses, presented as odds ratios (OR) and 95% confidence intervals (CI)

	OR ^a	95% CI	P-value	OR ^b	95% CI	P-value	OR ^c	95% CI	P-value
Primary school									
Walking/bicycling to school/bus stop	0.95	0.9–1.0	0.08	0.94	0.9–1.0	0.07	0.95	0.9–1.0	0.2
School bus	1.0	1.0–1.0	0.9	1.0	1.0–1.0	0.6	1.0	1.0–1.0	0.3
Junior secondary school									
Walking/bicycling to school/bus stop	0.95	0.9–1.0	0.1	0.95	0.9–1.0	0.2	0.98	0.9–1.1	0.6
School bus	1.0	1.0–1.0	0.6	1.0	1.0–1.0	0.2	1.0	1.0–1.0	0.1
Walking/bicycling to activities	0.95	0.91–1.0	0.02	0.94	0.9–1.0	0.01	0.94	0.9–1.0	0.05
Car/bus to activities	0.99	0.98–1.0	0.3	0.99	0.9–1.0	0.1	1.0	1.0–1.0	0.7

^a Adjusted for gender

^b Adjusted in addition for the corresponding journeys (one pair of school journeys in each regression equation)

^c Adjusted in addition for frequency of physical activity, time spent in front of a television/computer (quartiles), and wellbeing

LBP [3]. Our results confirm the findings of positive associations between distance of active school journey, leg muscle strength and aerobic capacity in a Norwegian survey [21]. The short distances covered by the active transport indicate that even short but frequent activity may be beneficial for low back health, and the results thus support the advice of 30 min daily walking given by American health authorities [24]. Although walking and bicycling are quite different with regard to body position, both activities may represent a healthier activity for the low back than competitive sports and extremes of physical activity. A U-shaped association between LBP and physical activity was indicated in a Finnish survey [27].

The hypothesis of an association between use of school bus and LBP was not supported, but sitting in the school bus was provocative for LBP in 17% of the rural adolescents. The lack of association may be due to the low level of exposure, the small study sample and the comfort of modern buses. Although vibration was not measured, sitting in the school bus probably involves an exposure to WBV of around 0.40m/s^2 , according to the Swedish Institute of Work Environment (Wikström 2001, personal communication); the limit for a corresponding caution zone is approximately 10 h daily according to ISO [11]. Even if that value may be lower for the softer tissues of children and adolescents, the exposure time of 50-min bus journey among the rural adolescents is still far below the caution zone. In addition, WBV may do less harm to children, because they probably do not sit in fixed positions in the bus. The results support conclusions reported in a review on risk factors for LBP, showing that studies now place less emphasis on conventional risk factors like WBV for disc degeneration and LBP [26]. Another review, however, attaches great importance to vibration as a factor for LBP among drivers of trucks, tractors, etc [4]. An alternative hypothesis, derived from Rose [17], is that the WBV factor may be diluted by a high level of car use from childhood for both rural and urban groups of adolescents.

The small size of the study, the lack of a representative sample and the small differences indicate the need for careful interpretation. Due to the small size, there is also a danger that existing associations may not be uncovered. The similarities with other studies indicate that this study may bring some general information: the 1-year cumulative prevalence was similar to the 51% figure reported in a Danish survey [10] and somewhat lower than French data of 83% [28], and the associations found between the control variables and LBP correspond to other studies [2, 6]. By using ordinal logistic regression analyses, more information concerning LBP was utilised, and some more covariates could be included in the analyses. The small size of the schools and the careful collection of individual data

means that the information given from the headmasters is likely to have been reliable. The cross-sectional design does not permit causal explanations, but school journeys in primary school were probably performed before the onset of LBP for many of the pupils, as LBP usually increases with age [2].

Heavy backpacks may have been a confounder [15, 28], but no pupils mentioned that factor in answering the open questions concerning LBP-provoking activities. Smoking was not measured, and may have been another confounder [6]. The headmasters reported that smoking was hardly ever observed among the pupils. Walking and bicycling to school were registered together, because the adolescents reported that it was impossible for them to discriminate. The pupils were not allowed to bicycle to school for the first 4 years in primary school in either area.

Use of cars and buses may impact on low back pain in three ways: exposure to sitting, to WBV, and reduction of active transport. Our results indicate that transport by school bus for 1 h daily may not be hazardous for low back health. The results also indicate that low levels of active transport may be associated with juvenile LBP, and raise the question of whether the reduction in active transport may be one cause of the increase in juvenile LBP. The reasons for not walking/bicycling to school may be due to lack of pedestrian routes, long distances, attitudes among parents and pupils, and/or the family organisation of daily life. The results from this and other studies indicate that pedestrian routes should be established in residential areas, and that parents should be informed that by using the car to take their children to school and to other activities, door to door, they deprive them of an easy way of taking physical exercise, and that this is probably associated with low back health. Further research is needed to investigate whether the findings of this study are reproducible in other and larger settings, and in other age groups. Future research might investigate associations between longer active and passive journeys, LBP and degenerative changes.

Conclusions

The results indicate that juvenile LBP may be associated with lack of walking or bicycling, but not with use of the school bus for 1 h daily. However, unnecessary use of school bus or car from door to door may deprive children and adolescents of walking or bicycling. Further research is needed to explore whether active transport may be a relevant means to prevent juvenile LBP.

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