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Prevalence and independent risk factors of low back pain among Lebanese school adolescents: a cross-sectional public health study

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Abstract

Background

Pediatric low back pain is an escalating public health challenge globally, yet epidemiological data from the Middle East and North Africa region remains scarce. This study aimed to determine the prevalence of low back pain among Lebanese adolescents and to identify the independent individual, behavioral, psychosocial and environmental risk factors contributing to this burden.

Methods

A cross-sectional epidemiological study was conducted among 746 adolescents in Beirut, Lebanon, utilizing a multi-stage stratified cluster sampling method. Data were collected via a standardized questionnaire adapted from the Nordic Musculoskeletal Questionnaire and the Oswestry Disability Index. A Multilevel Mixed-Effects Logistic Regression and an Ordinal Logistic Regression were employed to evaluate the independent effects of sex, age, Body Mass Index, screen time, perceived backpack weight, and classroom furniture comfort on the lifetime prevalence and severity of low back pain.

Results

The lifetime prevalence of self-reported low back pain was 73.3%. The multilevel model identified female sex as a highly significant independent predictor (aOR: 2.55, 95% CI: 1.79–3.63, $p < 0.001$). Modifiable environmental factors heavily impacted musculoskeletal health: extended weekly screen time increased the odds of low back pain (aOR: 1.18, 95% CI: 1.05–1.33, $p = 0.006$), as did the perception of carrying a heavy backpack (aOR: 1.46, 95% CI: 1.14–1.88, $p = 0.003$). Conversely, the self-reported comfort of classroom furniture served as a significant protective factor (aOR: 0.80, 95% CI: 0.64–0.99, $p = 0.043$). These factors significantly drove higher levels of functional disability. Age and continuous Body Mass Index did not retain statistical significance.

Conclusions

Low back pain is highly prevalent among Lebanese adolescents, driven significantly by lifestyle and school-related factors. These findings highlight the importance of considering low back pain within a multifactorial and systemic framework, where environmental conditions and daily activity constraints play a central role. Preventive strategies should therefore extend beyond individual-level interventions to address improvements in everyday environments and practices in which students are engaged, including school, .

INTRODUCTION

Low back pain (LBP) is increasingly recognized as a major global public health issue, not only among adults but also in pediatric and adolescent populations. Once considered a rare or transient complaint in childhood, epidemiological evidence now demonstrates that LBP prevalence rises steeply during adolescence, approaching adult rates by late teenage years [1, 2]. Beyond the immediate physical discomfort, early-onset LBP is associated with a heightened risk of chronicity, school absenteeism, reduced participation in physical activities, and significant healthcare utilization [3, 4]. Crucially, experiencing LBP during adolescence is one of the strongest predictors of recurrent LBP in adulthood, underscoring the urgent need to understand and mitigate early-life risk factors to prevent long-term musculoskeletal disability [5–8].

The etiology of adolescent LBP is complex and multifactorial, driven by intersecting individual, behavioral, psychosocial and environmental determinants. Contemporary adolescents are experiencing a rapid epidemiological transition characterized by increasingly sedentary behaviors, predominantly driven by extended recreational screen time and television viewing [9, 10]. Childhood LBP is a multifactorial condition, resulting from the interaction of physical, psychosocial and environmental factors. Key risks have already been documented: growth-related vulnerabilities [11], poor posture [12], prolonged sitting [13], heavy schoolbags [14], physical inactivity [15], and psychosocial stress [16]. All of which can increase strain on the developing spine. While isolated physical, psychosocial and environmental, factors have been extensively studied, the cumulative public health impact of these combined lifestyle and environmental exposures remains underexplored.

Despite the escalating global burden, the vast majority of robust epidemiological data concerning pediatric LBP originates from high-income Western countries [14, 17, 18]. There is a critical scarcity of literature from developing nations, particularly within the Middle East and North Africa (MENA) region. Lebanon presents a highly relevant context for investigation due to its unique socio-cultural dynamics and dense urban schooling environments. The lack of adequate consideration of key risk factors in Lebanese schools, coupled with rising sedentary habits among youth, creates a pressing need to evaluate the localized prevalence and systemic determinants of LBP to inform targeted public health interventions.

In the context of Lebanese schools, the accumulation of multiple risk factors—particularly those related to posture, prolonged sitting, sedentary lifestyles, and psychosocial constraints—points to a concerning situation regarding the development of low back pain among youth. This highlights the need to assess its localized prevalence and better understand its systemic determinants to inform targeted public health interventions.

Therefore, this study aims to address this critical gap in the literature. The primary objective is to evaluate the prevalence and functional consequences of LBP among a large cohort of school-going adolescents in Lebanon. The secondary objective is to identify the independent socio-demographic, lifestyle, and mechanical risk factors associated with pediatric LBP using a multivariable predictive model.

METHODS

2.1 Study Design and Participants

A cross-sectional epidemiological study was conducted among school-going adolescents enrolled in the intermediate educational cycle, specifically grades EB6 through EB9, across both public and private schools in Beirut, Lebanon. To ensure a highly representative sample of the urban adolescent student population, a multi-stage stratified cluster sampling methodology was employed, utilizing the educational institution and specific classrooms as the primary clustering units. The final analytical cohort comprised 746 students. Prior to the initiation of data collection, ethical approval was formally obtained from the relevant institutional review boards, and written informed consent was secured from all participating adolescents as well as their legal guardians.

2.2 Data Collection and Variables

Epidemiological data were gathered utilizing a standardized, self-administered questionnaire. The instrument integrated the validated Nordic Musculoskeletal Questionnaire to evaluate the prevalence of low back pain [19], alongside the Oswestry Disability Index to quantify the severity of functional impairment resulting from spinal discomfort [20]. Consequently, the study utilized two distinct dependent variables: the binary lifetime prevalence of low back pain (presence or absence) and the ordinal categorization of functional disability severity (ranging from minimal to severe impairment). The independent variables were carefully selected to encompass socio-demographic characteristics, lifestyle behaviors, and school-related physical exposures. These included biological sex, chronological age, calculated Body Mass Index, categorized weekly hours dedicated to screen time, the subjective perception of school backpack weight, and the self-reported perceived comfort of the classroom furniture utilizing a standardized Likert scale [21].

2.3 Statistical Analysis

Statistical analyses were performed to isolate the systemic determinants of pediatric low back pain. Categorical variables were described utilizing frequencies and percentages, whereas continuous variables were expressed as means and standard deviations. To ensure the robustness of the predictive models, diagnostic testing was first conducted; the Variance Inflation Factor was calculated for all independent variables to explicitly rule out the presence of multicollinearity, ensuring that variables such as Body Mass Index and screen time could be evaluated independently.

To appropriately account for the hierarchical nature of the multi-stage cluster sampling design, standard regression techniques were eschewed in favor of a Multilevel Mixed-Effects Logistic Regression. The specific school was introduced into the model as a random intercept, which mathematically controlled for the intra-cluster correlation and unmeasured environmental variances shared by students within the same educational facility. Subsequently, to analyze the secondary outcome of functional impairment, an Ordinal Logistic Regression (Proportional Odds Model) was constructed utilizing the categorized scores from the Oswestry Disability Index. The outcomes of these advanced models are reported as Adjusted

Odds Ratios alongside their corresponding 95% Confidence Intervals, with the threshold for statistical significance rigidly set at a p-value of less than 0.05. Goodness-of-fit was assessed utilizing marginal and conditional R-squared metrics for the mixed-effects model.

RESULTS

3.1 Cohort Characteristics and LBP Prevalence

The study cohort included a total of 746 school adolescents. The overall lifetime prevalence of self-reported low back pain within this specific demographic was found to be exceptionally high, affecting 73.3% of the surveyed students. Initial bivariate analyses revealed a stark and statistically significant gender disparity regarding musculoskeletal health, with female adolescents demonstrating a markedly higher prevalence of low back pain at 83.2%, compared to a prevalence of 62.9% among their male counterparts. Among those reporting pain, the Oswestry Disability Index revealed a spectrum of functional impairment, with the majority of affected students presenting minimal to moderate disability (56.3% of students reporting low back pain, n = 547), indicating. that the spinal discomfort actively interfered with daily adolescent activities, ranging from personal care to social participation.

3.2 Multilevel and Ordinal Predictors of Musculoskeletal Burden

Preliminary model diagnostics confirmed the appropriateness of the selected variables, yielding Variance Inflation Factor values consistently below 2.0, thereby confirming the absolute absence of significant multicollinearity within the predictive framework.

The Multilevel Mixed-Effects Logistic Regression, adjusting for the school-level clustering, demonstrated that socio-demographic, lifestyle, and school-related physical factors exert distinct influences on the etiology of pediatric low back pain (Table 1, Fig. 1).

Table 1
Multivariable Logistic Regression of Independent Risk Factors for Low Back Pain in Lebanese Adolescents

Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval (CI)	p-value
Socio-demographic Factors			
Sex (Female vs. Male)*	2.55	1.79–3.63	< 0.001
Age (Continuous, Years)	0.99	0.85–1.16	0.952
Body Mass Index (Continuous)	1.01	0.97–1.05	0.714
Lifestyle Factors			
Screen Time (Categorical increase)**	1.18	1.05–1.33	0.006
School-related physical factors			
Backpack Weight Perception (Increase)***	1.46	1.14–1.88	0.003
Furniture Comfort Perception (Increase)****	0.8	0.64–0.99	0.043

*The model is adjusted for the cluster sampling design at the school level. Significant p-values (< 0.05) are bolded. * Reference category: Male. ** Measured as categorical increase in weekly hours. *** Measured across categories: Not heavy, Moderately heavy, Too heavy. **** Measured across categories: Uncomfortable, Moderately comfortable, Comfortable (Note: aOR < 1.0 indicates a protective factor).*
We demonstrated female sex remained a highly significant independent predictor, with female adolescents presenting 2.55 times the odds of experiencing low back pain compared to males (aOR: 2.55, 95% CI: 1.79–3.63, p < 0.001). Extended sedentary screen time proved to be a robust risk factor; for every categorical increase in weekly screen exposure, the odds of a student reporting low back pain increased by 18% (aOR: 1.18, 95% CI: 1.05–1.33, p = 0.006). Crucially, the school-related physical exposures retained high significance. The perception of carrying a heavy school backpack elevated musculoskeletal risk by 46% for every categorical increase in the reported burden (aOR: 1.46, 95% CI: 1.14–1.88, p = 0.003). Conversely, higher levels of satisfaction with classroom furniture comfort were associated with a reduced risk of low back pain; for every incremental improvement in the self-reported comfort of classroom furniture, the odds of suffering from low back pain decreased significantly by 20% (aOR: 0.80, 95% CI: 0.64–0.99, p = 0.043). Neither chronological age nor continuous Body Mass Index retained statistical significance as independent predictors in this adjusted multilevel cohort.

Furthermore, the Ordinal Logistic Regression analyzing the Oswestry Disability Index scores revealed that these same environmental exposures heavily influence the severity of the condition. The perception of carrying an excessively heavy backpack and engaging in prolonged weekly screen time not only

increased the raw probability of experiencing low back pain but also significantly drove higher levels of functional disability, statistically shifting affected adolescents into more severe impairment categories that actively disrupted their daily educational and social functioning.

DISCUSSION

This study aimed to determine the prevalence and independent risk factors of low back pain among school-going adolescents in Beirut, Lebanon. We observed an alarmingly high lifetime prevalence of 73.3%, underscoring that pediatric low back pain is not a transient childhood complaint but a substantial public health issue in this region [4, 22, 23]. Through rigorous multivariable modeling, our analysis identified female sex, increased screen time, and the perception of carrying a heavy backpack as significant independent risk factor. Conversely, the self-reported comfort of classroom furniture emerged as a protective factor, highlighting the crucial, yet often overlooked, role of the educational environment in determining pediatric musculoskeletal health.

The observed prevalence of 73.3% sits at the higher end of the spectrum when compared to global epidemiological estimates, which typically report pediatric low back pain rates fluctuating between 30% and 70% in high-income nations [1, 24, 25]..This stark disparity may reflect specific localized environmental stressors, a rapid regional shift toward sedentary lifestyles, or a lack of preventative health infrastructure within the Lebanese school system. Consistent with extensive international literature, our multivariable analysis demonstrated that female adolescents are highly susceptible, presenting with more than two and a half times the odds of experiencing low back pain compared to their male peers [25–27]. This elevated risk is frequently attributed in the literature to the earlier onset of puberty and the associated rapid anthropometric changes in females, alongside potential psychosocial differences in pain perception and reporting mechanisms.

The significant role of both school-related and lifestyle factors in the occurrence of low back pain among students was also highlighted. Subjective perception of schoolbag weight emerged as an important determinant. Beyond the actual load, students who perceived their schoolbags as heavy or difficult to carry were more likely to report low back pain, suggesting that perceived strain may be more relevant than objective measures alone. This aligns with international evidence indicating that while the association between absolute schoolbag weight and low back pain remains debated, perceived heaviness and carrying difficulty are consistently associated with pain and persistent symptoms [28].

Similarly, perceived comfort of classroom furniture was identified as a protective factor, with higher satisfaction associated with a lower likelihood of low back pain. This finding supports the idea that the interaction between the child and their environment, rather than isolated physical characteristics of furniture, plays a key role. In the literature, mismatches between students and school furniture, as well as prolonged sitting in constrained postures, are frequently reported as contributors to spinal discomfort [29].

Lifestyle factors, particularly screen time and sedentary behaviors, also played a substantial role. Increased time spent using digital devices was associated with a higher risk of low back pain, likely due to prolonged static postures and reduced physical activity. International studies support this association, with evidence suggesting that exposure to three or more hours of daily screen time is linked to a higher frequency of low back pain [30], and meta-analytic data indicating a dose–response relationship, with an estimated 26% increase in risk for each additional hour of screen exposure [1].

Overall, these results reinforce the multifactorial and systemic nature of low back pain in children, where school-related constraints (e.g., schoolbag perception, furniture comfort, prolonged sitting) and lifestyle behaviors (e.g., screen exposure, physical inactivity) interact. This pattern is consistent with the broader international literature, which increasingly emphasizes the combined influence of environmental, behavioral, and perceptual factors on musculoskeletal health in youth. Traditional analytical frameworks, often focused on isolated risk factors, appear insufficient to fully account for the complex interactions between individual, environmental, and behavioral determinants. Global and situated approaches, capable of capturing the multifactorial nature of low back pain, are necessary. They aim to analyze real activity within its context and to understand how children interact with their environment under specific constraints. By considering the student as an active agent engaged in a structured and constrained activity, such approaches make it possible to move beyond fragmented analyses and to better grasp the dynamic processes underlying the emergence and persistence of low back pain. This perspective opens the way for more comprehensive and context-sensitive preventive strategies, grounded in the transformation of everyday environments and practices rather than in the sole modification of isolated risk factors.

This study benefits from an important multivariable methodological approach and a large, representative sample of Lebanese adolescents, providing critical epidemiological data from the under-represented Middle East and North Africa region. However, certain limitations must be acknowledged. The cross-sectional design inherently precludes the establishment of temporal causality between the identified risk factors and the actual onset of low back pain. Additionally, the reliance on self-reported questionnaires introduces the possibility of recall bias and subjective interpretation, particularly regarding the exact duration of screen time and the perception of furniture comfort. Future longitudinal cohort studies incorporating objective kinematic tracking and precise anthropometric-furniture mismatch measurements are recommended to validate and expand upon these findings.

CONCLUSION

This study demonstrates that low back pain is highly prevalent among Lebanese adolescents and is strongly associated with lifestyle and school-related factors. Beyond individual characteristics, the findings highlight the central role of environmental and behavioral exposures, screen time, perceived schoolbag load, and classroom comfort, in shaping musculoskeletal health during adolescence. These results reinforce the need to move beyond isolated risk factor approaches and to consider low back pain within a broader, multifactorial and systemic framework. In this perspective, preventive strategies should

not be limited to individual recommendations but should also address the everyday environments and practices in which students are engaged.

Declarations

Ethics approval and consent to participate

All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The present research was designed strictly as an observational, cross-sectional epidemiological survey utilizing a standardized, self-administered questionnaire. Because the methodology evaluated normal educational practices, ergonomic perceptions, and lifestyle habits within a routine classroom setting without involving experimental or clinical interventions. Written informed consent was obtained from the parents and teachers of all minor participants included in the study. Additionally, verbal assent was obtained from the students prior to their participation, and formal written permission to conduct the research was granted by the participating school administration and classroom teachers.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

Gergi Antoun, Ahmad Rifai Sarraj, Jihan Allaw, and Roy Abou Zeid Daou contributed to the conceptualization, methodology, project administration, supervision, writing the original draft, and reviewing and editing the manuscript. Antonio Pinti and Sylvia Pelayo contributed to the formal analysis, methodology, project administration, validation, and reviewing and editing the manuscript. All authors read and approved the final manuscript.

Data Availability

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

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Figures

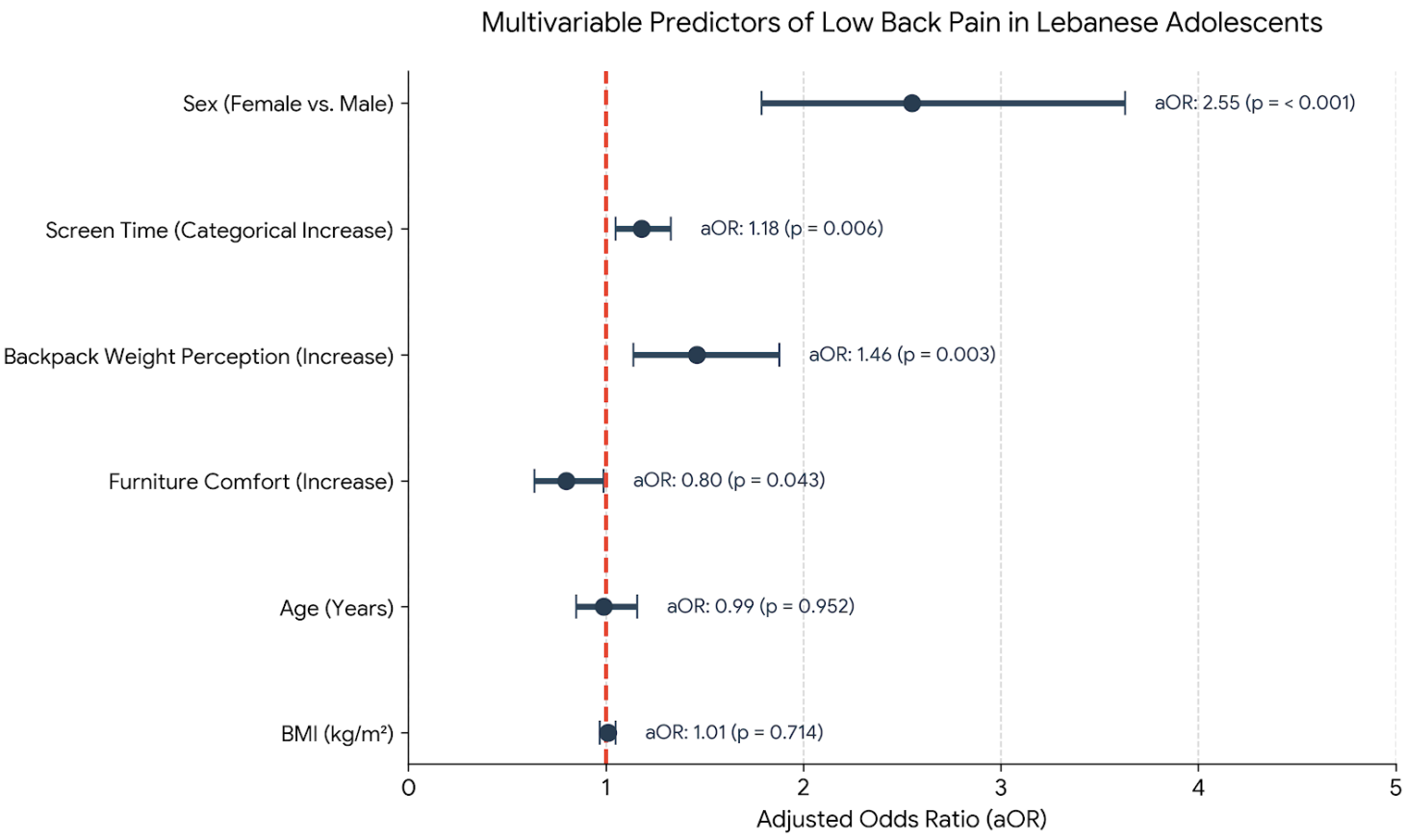


Figure 1

Forest plot of multivariable predictors of low back pain among Lebanese school adolescents. The graph displays the Adjusted Odds Ratios (*aOR*) and 95% Confidence Intervals (error bars) for socio-demographic, lifestyle, and ergonomic factors associated with the lifetime prevalence of low back pain. The vertical red dashed line represents the line of no effect (*aOR* = 1.0). Variables with error bars entirely to the right of the red line indicate a statistically significant increased risk, while those to the left indicate a significant protective effect.