Back Pain in the Young: A Review of Studies Conducted Among School Children and University Students

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Abstract: Back Pain [BP] represents one of the most common occupational disorders among human beings, with almost all people experiencing it at some stage during their life. Despite the well-known relationships between workplace factors and BP among adults, BP also affects younger people, such as school children and university students. Although some evidence suggests an increasing prevalence of BP throughout later childhood, it is difficult to ascertain whether this reflects a true increase in prevalence, or just greater recognition of the problem by researchers and research subjects. Nevertheless, various studies have begun to highlight a variety of BP risk factors in young people, such as classroom posture, backpacks, computer usage and psychosocial factors. As today's school children and university students may be a generation increasingly burdened by BP, it is essential that clinicians in the paediatric field keep abreast of contemporary issues and risks, so that they may more effectively deal with this growing menace.

Keywords: Back pain, children, adolescents, students, musculoskeletal disorders, risk factors

INTRODUCTION

Back Pain [BP] represents one of the most common and expensive occupational disorders worldwide, with around 60% to 80% of adults experiencing it at some stage during their life [1]. It also represents a common health-related reason for discontinuing work, and one of the most frequent reasons for seeking health care [2]. BP may present as a wide range of symptoms such as short, sharp pain, chronic dull ache, or a combination. The condition may be caused by readily identifiable injuries such as spinal disk degeneration, disk prolapse, muscle tears and spinal fractures; as well less distinctive symptoms such as muscle strains, sprains, muscle spasms, and so on. Although the subject has been well studied among adults for many years, the exact causes of BP are not completely understood. While there is reasonable epidemiological evidence that physical factors such as lifting, twisting, bending and other types of manual handling probably contribute to its development, the exact relationship between physical demands and BP is complicated and inconsistent [3]. Furthermore, there is a growing body of evidence to suggest that psychosocial factors may play a more significant role in the development of BP and other musculoskeletal disorders [4-6]. One major conundrum is the fact that BP is seldom characterised by a single, causative event [3]. In this regard, BP can be difficult to define from a clinical standpoint, due to the wide range of potential symptoms. Another issue is the variety of risk factors demonstrated in contemporary literature, ranging from work tasks, work postures, work control and work organisation; as well as personal factors such as older age, tobacco smoking, low physical fitness, tallness, high body mass index and leisure activities [7].

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THEORETICAL ISSUES OF BACK PAIN AND YOUNG PEOPLE

BP does not always result from an underlying physical condition. Despite the well-known relationship with work-related factors [1-3], BP may also affect younger people, such as school children and university students, often before they commence full-time employment. This situation raises some questions as to how important purely physical factors are, with respect to BP among the younger generation. One important issue has been the advent and widespread proliferation of Information Technology [IT] and how this now influences the daily life and behaviour of school children and university students. Young peoples' exposure to IT has risen dramatically in recent years, and there have also been significant changes in the way children work, play and learn [8]. Although educational institutions are increasingly looking to IT for new models of teaching and learning, IT itself has introduced a whole range of new ergonomic issues for the younger generation, many of which may have significant impact upon them [9].

The sequelae of poor posture when using computers, for example, may be particularly detrimental to the rapidly developing spines and ligaments of children. This represents an important consideration for children, who usually spend around one-third of their waking hours in school [10]. Indeed, it is not uncommon for children to seek medical attention because of BP. In Spain for example, de Inocencio [11] reported that 6% of all paediatric clinic visits by children aged 3 to 14 years were for some type of musculoskeletal pain. In Switzerland, Gierlach [8] found that physicians often

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treat children 10 years and younger for BP, possibly a reflection of the increasing proportion of sedentary and static activities among their demographic. Clinical investigations have begun to reveal early degeneration of children's spinal discs after the initial growth phase, many of which are often correlated with BP [12]. Hakala [13] has also shown that the problem may be increasing among adolescents, suggesting a disturbing trend for the future. Given that epidemiological investigations are clearly needed in this area, it is worth considering how BP research can and should be best performed.

VALIDITY OF BACK PAIN RESEARCH

Self-reporting surveys are a historically common method for establishing BP prevalence rates during epidemiological research among adults [3]. Nonetheless, the validity of simply using an adult-orientated measurement instrument on young people, particularly school children, is not without its limitations. In a longitudinal study of British school children for example, Burton [14] revealed that almost 60% of the participants forgot at least one BP episode during questioning in later years. In addition, Wedderkopp [15] demonstrated that self-reported activity did not always reflect the real-life situation of children. Another important methodological issue worth considering is exactly what aches, pains and disability mean to children themselves [16]. As all BP surveys are presumably conducted by adults, this may incur a certain degree of bias, by virtue of the 'adult model' and the adult understanding of BP symptoms, functional limitations, and so on. Surveying BP among university students also presents some methodological difficult-ties, as the latter tend to be more widely-dispersed than school children, who usually remain in a single classroom throughout the day. The intermittent nature of university lectures not only makes it harder to locate all students at a single point in time, but it also increases the possibility of responder bias, where individuals already suffering severe BP may simply be unable to attend lectures.

Despite these issues, the historical usage of self-reporting surveys to ascertain the prevalence of BP has often been validated over time [3], suggesting it to be a reasonably acceptable method for epidemiological research. When specifically targeting children, Staes [17] found that questionnaires used to ascertain back problems and functional limitations were quite reproducible. In another study, Staes [18] also showed that the results obtained from questionnaires and face-to-face interviews were similar, and the exact method used did not change interpretation of the results. Considering these findings, it can be suggested that self-reporting surveys offer a reasonably accurate and common method for describing the epidemiology of BP among school children and university students, despite the inherent limitations previously mentioned.

AIM OF THIS REVIEW

Given the increasing number of investigations which have been conducted in recent years, we considered it necessary to undertake a comprehensive review to help highlight the prevalence, distribution and risk factors for BP among young people. The review began with a Medline search for all articles published in English which contained the keywords of 'Back Pain', 'Child' and 'Student'. Additional searches were then conducted using the keyword 'Musculoskeletal Disorders', from which only those articles containing specific information on back pain were considered. Reference lists from manuscripts located using this initial method were then examined, to help locate further papers. As the nature of BP will tend to change over time and research quickly also goes out of date, we felt it necessary to limit our review to include papers published in the past 15 years. Overall, most of the manuscripts located had been published in the past 10 to 12 years, with a large proportion of them appearing since the year 2000. Using this search methodology, around sixty publications were located. As school children and university students represent a different social demographic in many respects, it was considered necessary to divide the review into four separate parts: BP among school children, BP among university students, BP risk factors for school children and BP risk factors for university students. The main results from these four areas were subsequently displayed as four separate tables.

MAIN METHODOLOGICAL ISSUES AND LIMITATIONS

A surprisingly large number of epidemiological studies appear to have investigated BP among school children in various countries [19-33]. The overall quality of these studies may also be improving somewhat over time, as evidenced by larger sample sizes, higher response rates and thereby, more inherently representative samples of the population. Probably the most representative studies have been undertaken in Finland [24] and Denmark [21], where sample sizes ranged from over 10 000, to almost 30 000 individuals. The majority of investigations appear to have been conducted upon school children aged between 10 and 18 years, possibly because this age group represents a concentrated sample that can be readily accessed by potential researchers. As for age groups, ten years may be the earliest practical age at which children can reliably complete self-reporting questionnaires. Interestingly, we were unable to find any studies where researchers had evaluated the practicality and reliability of questionnaires in progressively younger cohorts. This preliminary observation may highlight an important area for future research of BP, particularly among school children.

Another noteworthy trend was that most BP surveys appear to have been conducted among young people in developed countries. This is consistent with the observations of Rahman and Fukui [34], who suggested that biomedical research is often bias towards areas with higher economic ranking. Such prejudice represents a major limitation in the current body of knowledge in this field. Although there are almost 300 million Chinese people aged 0 to 14 years for example [35] few if any, studies of BP appear to have been conducted among them. Another confounding issue appears to be a lack of standardisation in BP recall periods, with the published studies using time periods ranging from BP occurring 'recently', within the last 7 days, 3 months, 6 months, 1 year, 2 years and ever (lifetime). Similarly, an index of severity does not always appear to be a consistent

Table 1. Back Pain Prevalence Rates Among Children by Recall Period and Year of Publication

Prevalence Rates			Study Details			Publication Details	
Country	**%** [a]	**Recall**	**Description of the Participants**	**Number** [b]	**Response** [c]	**Reference** [d]	**Year**
Kuwait	58%	Lifetime	10-18 Year Old Schoolchildren	400	100%	[32]	2005
United Kingdom	40%	Lifetime	10-16 Year Old Schoolchildren	500	93%	[31]	2004
Spain	61%	Lifetime	13-15 Year Old Schoolchildren	7361	93%	[28]	2003
Finland	26%	Lifetime	12-18 Year Old Children	11 095	77%	[24]	2000
Belgium	36%	Lifetime	9 Year Old Children	392	100%	[22]	1999
United States	30%	Lifetime	7th-9th Grade Schoolchildren	1242	99%	[19]	1992
Denmark	23%	1 Year	14-16 Year Old Children	2533	86%	[30]	2004
Norway	58%	1 Year	8th & 9th Grade Schoolchildren	105	84%	[29]	2004
Taiwan	37%	1 Year	10-12th Grade Schoolchildren	471	86%	[26]	2003
Denmark	51%	1 Year	8th-9th Grade Schoolchildren	1389	100%	[23]	1999
Denmark	7%	1 Year	12 Year Old Children	29 424	86%	[21]	1998
Finland	10%	1 Year	7-16 Year Old Schoolchildren	1171	82%	[20]	1997
United Kingdom	19%	1 Month	11-14 Year Old Schoolchildren	933	89%	[27]	2003
United Kingdom	24%	1 Month	11-14 Year Old Schoolchildren	1446	97%	[25]	2002
Denmark	39%	1 Month	3rd & 9th Grade Schoolchildren	1020	75%	[15]	2001
New Zealand	35%	7 Days	7th & 12th Grade Schoolchildren	140	100%	[33]	2005

[a] Prevalence rates rounded to the nearest whole number, [b] Number of participants in the study, [c] Response rate of the study, [d] Reference number as listed in this manuscript

feature of BP research conducted among young people. This may arise due to the inherent difficulties in assessing BP over time, and the fact that many projects are conducted as a cross-sectional survey describing the point prevalence of a particular group. On the positive side however, survey sizes were generally shown to be quite large during this review (ranging from hundreds to tens of thousands), while their response rates were also impressive (with most capturing 75% or higher). In terms of sheer sample size, research from Israel [10], Denmark [21] and Finland [24] was particularly impressive.

BACK PAIN AMONG SCHOOL CHILDREN

From the publications examined during our current review, a number of important issues can be established with regard to BP prevalence. Firstly, the absolute prevalence of BP among school children appears to vary widely, from country to country, from year to year and between the various ages of participants. Among 12 year-old children in Denmark for example, Leboeuf-Yde [21] demonstrated that the 1-year prevalence rate was 7%. In Norway however, over half the students reported suffering BP in the previous year, even though they were of roughly similar age as the former group [29]. In the United Kingdom, BP prevalence rates appear to vary between 19% [27] and 40% [31], although a large component probably reflects different recall rates used in these different studies. An optimal recall time period for BP is difficult to establish among children however, as few adults may recall having any BP before the age of 18 [14]. In any case, due to the complexities of children's thought processes and their comprehension of musculoskeletal diseases, symptoms, and so forth, the exact usefulness of a figure reporting 'lifetime' BP among them may be distinctly limited. Nevertheless, as indicated in Table **1**, a reasonable proportion of surveys still appear to use such a measure as their primary criteria [19,22,24,28,31,32]. The development of an internationally standardized definition for BP studies among children, with a defined and agreed recall period, may be very useful for future research projects of this nature.

Aside from the prevalence rate itself, It is interesting to consider at exactly what age BP first begins to affect school children. Similar to our earlier comments, the age at which BP becomes problematic appears to depend heavily on the study methodology, the exact definition of back pain and what degree of confidence can be obtained from the data. Definition of the concept 'problematic' BP is also subjective, and also the prevalence rate at which a researcher decides that a particular condition is excessive within a particular population [16]. Possibly the best solution to this conundrum is provided by Leboeuf-Yde [21], who conducted a large study of almost 30 000 individuals in Denmark, born between 1953 and 1982. The authors concluded that BP increased in the early teenage years, more quickly for girls than boys. In this regard, when girls reached 18 and boys 20 years of age, over half of them had experienced at least one BP episode. Although BP appears to affect a reasonable proportion of young people at any one time, it may also develop into a chronic condition. Salminen [36] for example, conducted a 9-year prospective study of children in Finland and concluded that 2% to 3% suffered reoccurring or continuous BP up until to early adulthood. In the United Kingdom, Burton [14] reported the lifetime prevalence of Low Back Pain [LBP] among children rose about 10%

Table 2. Back Pain Prevalence Rates Among University Students by Recall Period and Year of Publication

Prevalence Rates			**Study Details**			**Publication Details**	
Country	**%** [a]	**Recall**	**Description of the Participants**	**Number** [b]	**Response** [c]	**Reference** [d]	**Year**
Turkey	41%	Lifetime	University Students [All Years]	1527	98%	[47]	2004
United Kingdom	81%	Lifetime	Nursing Students [2 x Training Yr]	80	92%	[38]	1993
Italy	23%	2 Years	Nursing Students [2x 1st Year]	344	57%	[39]	1998
China	40%	1 Year	Medical Students [4th Year]	207	92%	[51]	2005
Finland	54%	1 Year	Nursing Students [4 x 1st Year]	174	68%	[50]	2005
Korea	39%	1 Year	Nursing Students [Years 1-4]	202	75%	[48]	2005
China	28%	1 Year	Nursing Students [2nd & 3rd Years]	57	100%	[45]	2004
Australia	59%	1 Year	Nursing Students [Years 1-3]	260	92%	[43]	2004
Australia	63%	1 Year	Physiotherapy Students [Yrs 1-4]	250	72%	[42]	2003
Japan	14%	1 Year	Nursing Students [Years 1-4]	222	86%	[41]	2003
Australia	67%	1 Year	Nursing Students [2 x 1st Year]	694	74%	[40]	2000
United Kingdom	37%	1 Year	Nursing Students [3 x 1st Year]	199	53%	[37]	1993
Turkey	55%	6 Months	Dental Students [Years 3-5]	221	100%	[49]	2005
United States	26%	3 Months	Dental Students [Years 1-4]	271	85%	[52]	2005
Italy	33%	Recent [e]	Dental Students [Years 1-5]	114	99%	[44]	2004
Lebanon	37%	Recent [e]	Dental Students [Years 1-5]	178	100%	[44]	2004

[a] Prevalence rates rounded to the nearest whole number, [b] Number of participants in the study, [c] Response rate of the study, [d] Reference number as listed in this manuscript, [e] The term 'recent' was not clearly defined

annually. At 12+ years of age it was roughly 12%, rising to about 50% at age 15+.

This increase in prevalence may reflect an increasing probability of physical injury among children, over time. On the other hand, it may relate to the changing nature of children's activities as they move through to the higher grades of school. Whereas primary school students might be expected to have a large play component in their daily life, their older colleagues in middle school and high school probably have a proportionally greater exposure to computers, and thereby a greater burden from static postures, desk work and so on. Older students might also be expected to have more books to carry around than younger ones, thus increasing the weight of their backpacks. Although these results clearly suggest the existence of BP as an important issue in paediatrics, it is also worth considering what happens to young people who have just left school and moved onto tertiary study.

PREVALENCE OF BACK PAIN AMONG UNIVERSITY STUDENTS

Similar to previous studies that looked at BP rates among children, a relatively large body of research has also described the issue of BP among university students, as shown in Table **2**. The epidemiological rigor of university student research was however, more variable than for that conducted among school children. In this regard, almost all previous investigations of university students recruited less than 1000 participants [37-45]. In many cases this probably reflects the difficulty in sourcing and following-up such a highly mobile group as university students, as opposed to school children, who would presumably be less widely dispersed at any particular facility. Indeed, university students may be more reluctant to offer themselves as subjects during ergonomic research. Actually finding enough university students all together at one place and at one time can be difficult when considering the practicalities of large-scale BP research. Absentee rates can be a major consideration when conducting surveys during lecture periods, for example. Interestingly, when researching this topic we found that a large proportion of all BP studies targeting adolescents appear to have been conducted among nursing students [37-41]. This phenomenon probably occurs because working nurses are well known to suffer BP at high rates [3], and the investigation of their student counterparts may be useful in establishing a background level before entering the workforce. Regarding methodological rigor, it has previously been shown that age is an important consideration when researching BP among young people [46]. As such, it was encouraging to see that many studies of university students appear to have sourced participants of reasonably consistent ages [47-52].

The prevalence of BP among different groups of university students from different faculties is listed in Table **2**. Although their BP prevalence rate was shown to range from around 23% [39] to 81% [38], it was generally quite high. An unusually low BP prevalence rate was reported among nursing students in Japan however, suggesting the possibility of genuinely low prevalence rates, or, under-reporting due to cultural differences [41]. Australian nursing [40,43] and physiotherapy students [42] appear to report the

Table 3. Risk Factors for Children's Back Pain by Country of Study and Year of Publication

Identified Risk Factors		**Study Details**		**Publication Details**	
Country	**Items** [a]	**Description of the Participants**	**Number** [b]	**Reference** [c]	**Year**
Australia	Gender	8-12th Grade Schoolchildren	1269	[54]	2000
Denmark	Spinal Disc Degeneration	13 Year Old Schoolchildren	442	[61]	2005
Finland	Spinal Disc Degeneration	8th Grade Schoolchildren	1377	[36]	1999
Finland	Previous Pain Episodes	3rd & 5th Grade Schoolchildren	1756	[53]	1997
Greece	Carrying Backpacks	12-18 Year Old Schoolchildren	1252	[62]	2005
Italy	Carrying Backpacks	6th Grade Schoolchildren	237	[56]	2002
Kuwait	Age, Gender, Watching TV	10-18 Year Old Schoolchildren	400	[32]	2005
The Netherlands	Psychosomatic Factors	12-14 Year Old Schoolchildren	745	[57]	2003
Norway	Sitting at School	8th & 9th Grade Schoolchildren	105	[29]	2004
Norway	TV and Computer Usage	8th & 9th Grade Schoolchildren	88	[59]	2004
Norway	Lumbar Extension Strength	8th & 9th Grade Schoolchildren	88	[55]	2001
Taiwan	Psychological Distress	10-12th Grade Schoolchildren	471	[26]	2003
United Kingdom	Flexed Postures	11-14 Year Old Schoolchildren	66	[60]	2004
United Kingdom	Age & Gender	11-14 Year Old Schoolchildren	1446	[25]	2002
United Kingdom	Psychosocial Factors	11-14 Year Old Schoolchildren	933	[27]	2003
United States	Use of Backpacks	12-18 Year Old Children	1122	[58]	2003

[a] Risk factors identified during the study, [b] Number of participants in the study, [c] Reference number as listed in this manuscript

highest 1-year BP rates of all, not withstanding the report by Gladman [38] where a 'lifetime' recall period for BP was used. Similar to epidemiological research conducted among children, certain methodological shortcomings were also evident during some BP investigations conducted among university students. As previously mentioned, these tend to include inconsistent definitions of BP or recall periods, smaller sample sizes, lower overall response rates, and a bias towards certain occupational or student groups, particularly the nursing faculty, where a large proportion of studies appear to have been undertaken. The definition and usefulness of the recall period 'recently' for example, is uncertain. Broader factors may also exist which make it difficult to directly compare schoolchildren with adolescents, such as the different external influences and risk factors to which the different groups are exposed [43].

Although physical work stressors such as manual handling are commonly associated with BP among working adults [1-3], it is reasonable to assume that school children [aside from those living on farms] probably have limited exposure to such factors. University students on the other hand, may be expected to undertake at least some kind of part-time employment. External work influences may therefore influence the development and prevalence of BP among these age groups. Sporting and leisure activities undertaken by university students are also worth considering, as they may or may not differ from that of school children. This in turn, makes it difficult to conclusively separate age-effects when considering changes in BP prevalence. On the other hand, children living on farms may be exposed to significant manual labour, much earlier than their city counterparts [43]. Such factors will need to be further investigated and accounted for in future studies. Another topic in need of research is the exact age at which BP becomes a problem for university students. Although certain investigations have investigated children in this regard [14,21,36], there is a dearth of similar knowledge regarding university students, even though BP appears to be a very common problem among both groups.

RISK FACTORS FOR BACK PAIN AMONG SCHOOL CHILDREN

A summary of BP risk factors among school children is displayed on Table **3** [53-62]. Similar to prevalence rates, our review suggests that BP risk factors for children vary widely from study to study. The relative importance of these factors depends firstly on the quality of the study from which they came, and secondly, how many other investigations arrived at a similar result. Longitudinal studies of student groups are therefore, an ideal method for establishing risk factors in this regard. Although analysis of clinical data from paediatric consultations sheds some light on admission status [11], it is limited in its ability to define the actual causal links between behaviour, incidents and musculoskeletal disease. A retrospective chart review of paediatric patients by de Inocencio [11] for example, revealed that most admissions were caused by trauma, overuse or osteochondroses, in that order. Epidemiological studies which investigate risk factors, particularly those which are longitudinal, tend to paint a different picture however. A good example of this is the complicity of backpack use among children and the subsequent development of BP [63,64].

Table 4. Risk Factors for University Student's Back Pain by Country of Study and Year of Publication

Identified Risk Factors			**Study Details**			**Publication Details**	
Country	**Items** [a]		**Description of the Participants**	**Number** [b]		**Reference** [c]	**Year**
Australia	Age, Length of study, Sitting posture, Treating patients		Physiotherapy Students [Yrs 1-4]	250		[42]	2003
Australia	Previous history of BP, Current part time work, High GHQ [d] score		Nursing Students [2 x 1st Year]	694		[40]	2000
China	High self-reported mental pressure		Medical Students [4th Year]	207		[51]	2005
Finland	Patient handling skill, Twisted or bent work positions, High hysteria score, Smoking		Nursing Students [4 x 1st Year]	174		[50]	2005
Italy	Being a female psychology student, compared to males		Psychology Students [Years 1-4]	114		[44]	2004
Turkey	Age, Female gender, History of physical trauma		University Students [All Years]	1527		[47]	2004
United States	Male gender		Dental Students [Years 1-4]	271		[52]	2005

[a] Risk factors identified during the study, [b] Number of participants in the study, [c] Reference number as listed in this manuscript, [d] GHQ = General Health Questionnaire

It seems reasonable to assume that heavy loads acting directly on a child's back would probably influence the development of BP, similar to the manner in which heavy loads and manual-handling are common risk factors in the work environment of adults. Growing muscles and bones, particularly spines, may be particularly susceptible to heavy loads. Indeed, school backpacks may be unreasonably heavy, with Whittfield [65] demonstrating that some students carry around 13% of their body weight in a backpack. Heavy backpacks impose strain on children's backs in a variety a ways. Aside from direct pressure, the load may be particularly increased by running and jumping (which can lead to greater sudden loading), and also by poor carrying style (such as that which favours the dominant arm). Children tend to favour their dominant hand for carrying backpacks, a situation which may lead to an entrenched habit of poor posture. From a preventive standpoint, some researchers have suggested that, ideally, a schoolbag should comprise no more than 10% of a student's body weight [33]. However, backpack weight alone may not be solely responsible for BP in children, and reducing the weight they actually carry may not directly reduce the problem. Wiersema for example [66] looked at children's backpack injuries in the United States and found that almost 90% of them did not affect the child's back at all. In fact, the most common mechanism for injury was simply tripping over the backpack, while ten percent of children's injuries were actually caused by being hit with the backpack. Eliminating heavy backpacks from children, or even reducing the load they carry therefore, may not be a panacea in reducing overall BP rates.

Although it seems that backpack weights have been increasing in recent years, technological improvements and miniaturisation may mean that the burden from heavy books can be reduced in future generations of school children. The protective effect of physical exercise and its ability to help reduce BP levels is also debatable. While Smith [48] for example, showed that exercise appeared to reduce the risk of musculoskeletal disorders among Korean nursing students, this may reflect the fact that people already suffering BP may simply not be able to undertake regular exercise (a point acknowledged by the authors). Limon [10] went further to state that there is no conclusive evidence that physical activity can prevent BP pain in children. In a British study activity levels were related to BP only among boys [14], while in Denmark, Wedderkopp [15] demonstrated that physical activity was not related to low back pain at all. These results suggest that BP risk factors among children and adolescents are still not properly understood [67]. Although modifying certain risk factors can probably help prevent the development of BP [68], clinicians should take a cautious approach when evaluating such risk factors among children. As children may be disinclined to adopt correct classroom postures unless specifically instructed to do so, advice and counselling for parents and teachers should also be considered in paediatrics.

RISK FACTORS FOR BACK PAIN AMONG UNIVERSITY STUDENTS

A summary of BP risk factors among university students is displayed on Table **4** [40,42,44,47,50-52]. BP risk factors are well-known to be ambiguous among adults [7], with a wide range of studies reporting many different BP correlates, some of which are contradictory. Similar inconsistencies were seen among university student BP risk factors, particularly those relating to gender. In this regard, female gender was found to be an independent BP risk factor among students in Turkey [47]. Female psychology students in Italy also reported more BP than their male counterparts [44]. On the other hand, male dental students in the United States reported worse BP than their female colleagues at the same school [52]. As such, it is difficult to ascertain the true complicity of gender on BP development, and these conflicting results suggest that gender may often be a confounding variable, rather than a distinct BP risk factor. It is also possible that major demographic differences and large gender imbalances in certain courses such as nursing (where the majority are female), probably make it difficult to identify gender-related BP correlates. Nevertheless, a large university study from Turkey where the male to female ratio was roughly 1 to 1, did reveal female gender to be a clear risk factor [47], suggesting that females may indeed suffer a greater BP burden when they attend university. Larger population-based studies will be needed to confirm this hypothesis, however.

Aside from gender differences, other BP risk factors have also been identified by various authors. Age was shown to be a BP risk factor in two separate studies of university students in Australia [42] and Turkey [47]. The type of postures that students adopt during their daily life may be important [42,50], as too, a previous history of BP [40], smoking [50] and prior physical trauma [47]. The complicity of psycho-social factors has long been associated with BP and other musculoskeletal disorders among adults [4-6]. These issues also appear to be important among university students, with previous investigations revealing correlations between BP and high mental pressure [51], hysteria [50] and high scores on the General Health Questionnaire GHQ [40]. In a study of young people, Hestbaek [30] found some correlations between BP and headache, although the authors did not define which proportion of their sample were current university students. From a theoretical perspective, the increasing demands placed upon modern students by deskwork and computer usage should not be dismissed, as correlations between these risk factors and musculoskeletal pain in other body regions aside from the lower back, have also been demonstrated [70]. Given the risk factors which have been specifically related to this group, it appears that university students probably incur risks which comprise a mixture of those seen in children and adults.

RECOMMENDATIONS FOR THE FUTURE

Aside from describing the prevalence and distribution of BP among young people, this review has also highlighted various BP risk factors which need to be addressed. One area in need of attention may be the issue of international standards. Although the complicity of backpack use and heavy backpacks among school children is well-known, there appears to be a dearth of international standards specifically covering acceptable backpack weights. In Australia for example, the most relevant standard is probably HB 136:2004: Safety aspects - Guidelines for Child Safety, published by Standards Australia [71], although it does not appear to make any direct reference to appropriate backpack weights. Similarly, ASTM International - Standards Worldwide, has a standard for measuring backpack capacity (F2153-01 Standard Test Method for Measurement of Backpack Capacity) [72], but again, this does not provide any appropriate limit for backpack weights. The ASTM standard is simply a test method that determines and standardizes the unextended and extended capacity of backpacks and related bags. It is designed to provide a means whereby manufacturers and consumers may have a consistent measure to compare pack volumes [72]. Similarly, the International Ergonomics Association [IEA] Technical Committee has developed certain ergonomic guidelines for children and educational environments (*Applying Ergonomics in Educational Environments*) [73], but it appears to focus mainly on computer use. Although ergonomics practitioners have considered the issue of backpack weight for some time and proposed some general guidelines [33], the development and enforcement of an international standard in this regard would be very useful in helping reduce the prevalence of BP among children.

The continued management and prevention of BP will be multifactorial and complicated. Differences in body mechanics and the forces to which children's backs are exposed for example will vary throughout childhood, as play time decreases and study becomes a larger component of their daily life. By the time young people reach university for example, leisure time is severely curtailed and study has often become the main activity. The aetiology of BP among the younger generation is also changing in recent years. While it is possible that an increasing reliance on electronic devices rather than school books may steadily reduce the weight of children's backpacks, increasing computer use in itself will add a new dimension to the problem. With greater exposure to computers at younger ages, the location of musculoskeletal pain among young people may shift away from the back, and more towards the upper body. As poor neck and shoulder postures have previously been suggested as a cause of upper body pain in computer users [74], this type of problem may also incur a significant burden for future generations of school children.

In combating the current BP epidemic, the adoption of established preventive measures which are currently used in white-collar workplaces may also be useful for school children, particularly if implemented at the earliest possible age. In this regard, it may be useful for all school teachers to undergo at least some type of ergonomics training as part of their license requirements, so that they can help children learn early in life the importance of sound postures, rest breaks and so on, when using computers. University students should also be trained in a similar manner, perhaps as part of their occupational health lectures, regardless of the course being undertaken. As young people represent the adult workers and the adult BP sufferers of tomorrow, preventive measures should not only begin early (ideally at primary school), but should also be constantly reinforced throughout their student life and into early adulthood. The development and implementation of training programs tailor made for young people will be an important step in combating the apparent rising prevalence of BP as an international occupational health burden.

CONCLUSIONS

Overall, this review suggests that BP is probably common among young people, with many studies documenting a reasonably high prevalence rate within school children and university students. Although some evidence even suggests an increasing prevalence throughout adolescence, it is difficult to establish if this reflects biomechanical, physiological or psychological factors, or simply a greater detection of the problem. Nevertheless, as today's young people appear to be a generation increasingly burdened by BP, it is essential that clinicians in the paediatric field keep abreast of contemporary issues and risks, so that they may more effectively deal with this growing menace.

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