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A trans-generation conundrum with implications in rehabilitation programs – what factors influence non-specific back pain in children?

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Abstract: Back pain in children and adolescents is one of the most frequent reasons for seeing a medical specialist worldwide. Many factors have been incriminated when it comes to influencing the appearance of non-specific back pain in children as well as in adults. For the younger population, some of the culprits seem to be sitting for long periods, us-ing harmful postural patterns, a forward head posture determined by incorrect positioning during prolonged studying hours, and carrying a too-heavy backpack, but do they really influence non-specific back pain in children? These questions are valid for all generations and countries.
This paper aimed to review the published literature to determine whether the factors mentioned above, sitting in mismatched school furniture, carrying heavy backpacks, and forward head posture, influence the incidence of non-specific back pain in children and whether there are any data or differences between the general population and Roma-nian students. For this purpose, we conducted database research using the keywords "non-specific back pain in chil-dren, sitting, school furniture, forward head posture, backpack carrying" and various combinations of these terms, which returned 37 eligible articles for this paper in PubMed - Center for Biotechnology Information (NCBI) and Sci-enceDirect. There was no time limit on the researched articles, and they had to refer to the pediatric population, be open-access and in extenso articles, and be written in English, French, or Spanish.
After analyzing the results from these articles, the conclusion is that there is no evident or spe-cific connection between non-specific back pain in pediatric populations and harmful posture patterns while sitting or carrying a backpack. Also, more multicentered research using fewer variables and more objective measurement instruments is needed.

Keywords: non-specific back pain in children, sitting, bad posture, school furniture, forward head posture, back-pack carrying

1. Introduction

Non-specific musculoskeletal pain (MSP) is one of the most frequent pathologies worldwide, regardless of age, and it represents a global public health problem in all genders and ages [1 – 4, 6, 7, 22]. In all economic settings, developed and developing coun-

tries, non-specific back pain (BP) – the most common form of MSP - is considered recurrent and costly, as it is the number one cause of medical presentation and medical absenteeism [5]. Until the late 90s, it was believed that the young population, mainly under 20 years of age, rarely suffered from BP, and if they did, it was likely because of a tumor or local infection [1]. Later studies showed that BP is as frequent in young age as in the rest of the population [2 - 7].

Common causes for non-specific BP in children and adolescents are coronal and sagittal plane spinal curvature deviations, such as scoliosis, non-structural hyperkyphosis, and hyperlordosis, followed by Scheuermann's disease as a cause for structural hyperkyphosis. The most common spine pathology in the young population is represented by scoliosis, mainly adolescent idiopathic scoliosis (AIS), which affects 1 to 3%, depending on the region, even 4,5% of all children and adolescents [8 - 11].

In all developed and developing countries, school studying hours for children and adolescents tend to cover at least 6 hours per day, not including homework time, which varies depending on age and country from 0 to 3 hours per day. Accordingly, most of this studying time is spent sitting in a forward head position, which is necessary for reading and writing activities. This means the developing lumbar spine and pelvis are exposed to more pressure [12]. There is an ongoing discussion among parents, tutors, medical staff, and political decisional factors about how much sitting is too much and how or if this position affects the developing spine of children and adolescents, and if so, is it for the short or long term?

Another important issue related to schoolchildren and adolescents is the school backpack: how big, how heavy, how much time, what type, and so on. These questions interest parents and caregivers as well. All these questions require an answer as to whether there is a connection between non-specific BP in children and young people and their backpacks' use for school [13 - 18].

On top of school-related activities that promote forward head posture, handheld electronic devices are used starting at a very early age, sometimes as soon as two years old, and the recreational activities that involve these handheld electronic devices [19 - 21]. During the COVID-19 pandemic, all schooling activities took place online, making electronic devices a must for learning and exponentially increasing exposure time for children and adolescents. Even if the pandemic ended, the use of electronic devices in schools has not decreased. Is this another factor that adds to non-specific BP in young populations?

This paper aims to try and answer the following questions:

- Is sitting for long periods related to non-specific PB in children?
- Is forward head posture related to non-specific BP in children?
- Is the use of backpacks related to non-specific BP in children?

It is essential to try to answer the above questions since a connection seems to exist between the incidence and prevalence of non-specific back pain in youngsters and how much time they spend in incorrect posture in schools and while carrying backpacks. School schedules and overall school design can be improved, and in time, the economic burden of treating these patients will be reduced. Also, better prevention programs and policies can be developed.

2. Results

a. Sitting and non-specific BP in children

As mentioned, preschool and school-aged children tend to sit down for prolonged periods during the school year, as almost all learning activities happen in this position. Ordinarily, school furniture is expected to meet the anthropological needs of children, such as age-related height, elbow height, knee height, popliteal height, sacral-popliteal length, etc. Unfortunately, the existing furniture has not met these anthropological measurements in schools since children in the new generations tend to get taller and weigh more than older ones. Also, because of a developmental gap between girls and boys, the former reaching growth spurs 2-3 years earlier. This situation forces children to sit for 6

to 7 hours per day, either with insufficient space for their lower extremities, keeping them in a more closed-pack position, or slumping over their desks because these are too low.

An array of studies (Table 1) shows that almost everywhere in the world, there is a mismatch between school furniture measurements and children's anthropology [23-32]. Some of these studies mention a mismatch as high as 72% between the two – in developing countries, with the lowest mismatch rate of 16% - in Spain. The study participants answered a range of BP questionnaires, showing a varying BP incidence of 7 to 78% for children using mismatched school furniture. However, there was no direct correlation between a high mismatching rate of anthropological measurements and furniture size and a higher rate of BP in any of the studies.

In the literature, there is also a common conclusion, understanding that it is pretty challenging to compare different age groups in various countries, as some have a curriculum that is based on practical experience, which means that children spend their time in different school settings during the same day, while other countries have a curriculum that is based on theoretical knowledge – meaning that here children will spend more time in fixed settings during learning hours.

Studies about the biomechanics of sitting mainly involved adult populations [12] and were conducted in Scandinavian countries. These research results are being used for production by furniture manufacturers worldwide, with minor adaptations. Adaptive school furniture is more expensive than standard furniture, and the decisions about its use in public schools depend on local, regional, or country budgets, which vary considerably [32].

Authors	Year	Country
Parcells et al.	1999	USA
Skoffer et al.	2007	Multi centered
Brewer et al.	2009	Multi centered
Dianat et al.	2013	Iran
Castellcucci et al.	2016	Chile
Lu et al.	2017	Indonesia
Assiri et al.	2019	Saudi Arabia
Satir et al.	2021	Türkiye
Gutierez-Santiago et al	2021	Spain
Prieto-Lage et al.	2021	Spain

Table 1: Country distribution for studies on mismatching school furniture size

There is no published data on Romanian school-aged children and the effects of mismatched school furniture on their health.

b. Forward head posture and non-specific BP in children

While seated in the classroom during writing activities, children must bend forward over the desk. Even if the desk is situated at an appropriate height, this still puts them in a forward head posture, with much tension on the head and neck extensors, for at least 2-3 hours per day. The time spent at the desk for school-related activities is extended because most of the recreational activities of children and adolescents are computer or electronic handheld device-oriented. There is a lot of published literature concerning the positive connection between this position and neck and back pain in children [33-36, 39]. At the same time, other meta-analyses find this connection is only relevant for older populations rather than for adolescents [38]. Prolonged forward neck posture also influences the regular breathing pattern, causing children to have a reduced exercise capacity [37].

The consensus is that for children and adolescents, non-specific BP, specifically neck pain, is more related to excessive use of electronic handheld devices than to bad posture at school activities. This is because, in the last twenty years, the accessibility of this type

of device has increased, along with the decrease in the age at which children start to use them regularly.

The COVID-19 pandemic has forced the teaching systems to move from on-site to online, increasing screen exposure for all ages. Screen time was also added because it was the only way to connect socially. Statistics show that screen exposure did not decrease significantly when the pandemic ended, especially for the school-aged population [40 - 42]. There was also an increase in mental health problems, mainly depression, in adolescents and children related to social media behavior and pressure and social isolation, with no significant change after the pandemic restrictive measures were lifted.

c. Backpack carrying and non-specific BP in children.

For adult populations, it is a known fact that carrying heavy loads leads to acute or chronic low back pain and changes in spinal biomechanics [43]. By social agreement, it is not recommended for children and adolescents to carry heavy loads; this does not exempt them from their school backpacks, which tend to have varying weights depending on age and state curriculum. The rules used for a correct load on the trunk while carrying a backpack are the following:

- for children, the weight of the backpack should not exceed 10% of the child's weight,
- both shoulder strapping should be used for symmetric loading,
- the backpack should be placed as high as T_7 on the child's trunk [43, 45].

While using backpacks, the trunk leans forward, and the head and neck push up and forward to compensate for the load center change [43]. Traditionally, the best position for carrying backpacks in relation to the trunk is to place the load at midthoracic to lower thoracic level, T_7 to T_{12}. Still, experimental studies show that in the adolescent population, there was less forward-leaning, which means less sagittal plane change, when loads were placed closer to L_3 - which is waist level [45]. Also, comparing the postural response to backpack carrying from adult and adolescent populations, there was no significant difference between them. The same was true for the gender comparison [45]. The least forward displacement of all anatomical parts was obtained when carrying the load at the L_3 level, which means it was as close as possible to the waist level [45]. The same study found no evidence concerning backpacks' 10% weight limit. A previous study noted that measuring a head-on-neck angle is not the most sensitive measure for showing postural changes in adolescent populations while carrying a backpack, even if that is the most visible change in spine positioning [46].

A Portuguese study found that in a sample of 966 children aged 10 to 14, the ones with bad posture when sitting and standing were more prone to non-specific back pain, independent of the postural pattern [44].

A literature review from 2004 showed that there is no significant difference between carrying a backpack using both shoulder straps or only one – and even here, it did not matter which one was used, left or right, as all evaluated groups had medical presentations or medical leave because of back pain [47]. Even if modern backpacks are more ergonomic, distributing the load as evenly as possible, the young population and their parents are significantly influenced by social media tendencies and fashion so as not to buy or use them in the most effective way [47].

Another literature review from 2020 evaluated the results from 22 studies, where 1159 persons, ages ranging from 7 to 27 years old, were checked for the changes in spinal posture determined by backpack loading. [48] Their findings included results reflecting the changes that backpack weight, position, and carrying height impose on the spine. These findings vary from study to study because of differences in measurements, dynamic or static, age, and skeletal maturity. Their conclusions state that more research is needed to determine if there is a direct causality between backpack carrying and non-specific BP in young populations [48] or whether the time of use or the weight of the backpack directly influences the characteristics of back pain in children and adolescents [49, 50].

3. Discussion

a. Sitting and non-specific BP in Romanian children

There are many variables regarding school design and use of specific furniture, and there needs to be a consensus regarding how it influences non-specific back pain [51]. These facts depend on the local/ regional/ state politics, ranging from budgets to underage population numbers, which affect how many schools there are, how many students are in one class, how much room each student is allocated, and so forth. The European Union has laws that determine how kindergartens, schools, and teaching spaces should be designed, and also, in the last 20 years, there were more than 5 billion euros of European funds allocated to rebuilding, renovating, and refurbishing schools all over the continent [52]. Even if there is so much money available for school buildings, we did not find in our search recent studies related to furniture design for children; all the manufacturers are still using design concepts developed in the late '80s and '90s research, which is based on the adult population.

As mentioned, no Romanian studies have been conducted on the hazards of prolonged sitting for adults or young populations. Compared to the rest of Europe, Romania still has an information-centered curriculum, not a practice-centered curriculum. This makes children and adolescents spend an average of 6 hours per day sitting at school, with an added 2 hours at home related to homework volume and extracurricular activities. Even children under ten and 4th grade spend the same amount of time sitting because most of them in urban areas go to an afterschool facility when they finish classes. Also, another aspect that is different for Romanian school children is that many metropolitan areas use the same classrooms for children 6 to 10 years old, 0 to 4th grade, and for adolescents 11 to 14, 5th to 8th grade, due to lack of buildings. This fact makes furniture and anthropological measurements mismatch even more, as younger and older children have to use the same size for the furniture. Compared to other countries in Europe, Romania has only 1 or 2 hours of physical activity per week in public schools' curriculum, which is one of the lowest on the continent [53]. This fact exposes younger generations to a higher risk of sedentarism and associated disease, which in turn increases the risk for non-specific musculoskeletal pain, including back pain.

b. Forward head posture and non-specific BP in Romanian children

Most of the meta-analyses used for this review did not show a positive casualization between modified spinal posture and low back pain or severe scoliosis development. Still, there were direct links between forward head posture, specific for prolonged sitting and electronic handheld devices, and non-specific neck pain [49]. Children who tend to spend more than 2 hours per day on this type of device are more anxious and more prone to depression, which are known factors for decreasing pain thresholds and playing a role in centralization of chronic pain, most likely increasing pain perception.

There are no Romanian-centered studies in this line of research. Still, an empirical evaluation shows that Romanian children have the same exposure time to electronic devices as the rest of Europe. As everywhere in the world, this exposure increased significantly during the COVID-19 pandemic, with a tendency to use more electronic devices in teaching when the pandemic ended.

c. Backpack carrying and non-specific BP in Romanian children

Due to the state curriculum for all grades, Romanian children must carry their books and notebooks daily. Romanian state schools do not provide individual cabinets to store personal schooling materials; as mentioned before, the children need their books and notebooks to complete their homework. This means they must carry about 5 to 6 books and another 5 to 8 notebooks daily, totaling an average of 7-8 kgs. This is currently considered to be a manageable load.

Another difference between Romania's urban and rural young populations is the different exposure times to carrying backpacks. In urban areas, most children use urban transportation or family cars to get to school, while in rural areas, they walk to school.

The reviewed literature found no conclusive scientific relationship between backpack carrying and non-specific BP. Still, some studies show that children and parents connect the two [13, 14]. In Romania, when addressing health practitioners about their back pain, most parents and children make the same connection, even if they carry their backpacks for less than 10-15 minutes daily.

All three lines of interest reviewed in this paper are highly controversial when it comes to decision-making, whether political – how much money to budget for schools' furniture/ what is best for promoting learning – media teaching or classic teaching, medical – what is the best preventative or rehabilitative advice for non-specific back pain, or parental – how much time do we allow for electronic handheld devices use, how much weight to carry to school, and so forth. The findings in the reviewed published literature varied for all three of them, with not one definitive conclusion. Some evaluated parameters changed over the years because of newly developed measurement devices, more accessible access to objective instrumental measurements, or a better understanding of biomechanics [48]. We did not find multicentered studies using the same parameters, starting with age ranges, to the exact biomechanical measurements for any of the three reviewed lines, which made clear and definitive conclusions quite hard to obtain.

4. Materials and Methods

This narrative review was designed using the following databases scoped for selecting eligible articles: PubMed - Center for Biotechnology Information (NCBI) and ScienceDirect. The keywords used were "sitting and back pain in children," "forward head posture and back pain in children," and "backpacks and back pain in children" (Table 2).

Keywords	PubMed	ScienceDirect	Total
"Sitting and back pain in children"	11	15220	15231
"Forward head posture and back pain in children"	1	4728	4729
"Backpacks and back pain in children"	10	697	707

Table 2. Centralization of the keywords

Inclusion criteria:

- The pediatric population had to be included in the studies,
- In extenso article,
- Free access article or access through "Ovidius" University of Constanta Electronic Library,
- Language: English, French, Spanish.

After applying the inclusion criteria, only 37 articles were evaluated [1-3, 7 13-32, 35, 36, 39-47, 49, 50]. Some of the keywords overlapped in the results of these articles, so when this happened, they were used for all three research sections in this paper.

5. Conclusions

The published data so far has made no apparent connection between the incidence of non-specific low back pain in children and young adults and their daily habits/ patterns of sitting in class, their forward head posture due to excessive use of handheld electronic devices or mismatching school furniture, or the weight, position, and exposure time to backpack carrying.

However, the general perception is that all three factors influence the well-being of school children, increase the number of presentations to the doctor due to back pain, and increase medical leave time.

More specific research is needed on non-specific back pain in the pediatric population, which is multicentered, independent of political factors, and uses objective and validated measure instruments.

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