



# Prevalence and Factors Associated with Musculoskeletal Pain among Secondary School Students

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## ABSTRACT

**Aim:** The purpose of this paper is to examine the factors associated with the occurrence of shoulder pain, neck pain, upper back pain and lower back pain with particular focus on carrying schoolbags.

**Method and Materials:** A questionnaire containing a range of MusculoSkeletal Pain (MSP) related information was designed specifically for a group of schoolchildren aged 11 to 20 years and distributed to Grade 7 to Grade 13 students attending three main secondary education schools in Mauritius over the period July 2017 to February 2018. A total of 1048 questionnaires were circulated out of which 849 were useable. The study analyzed the impact of socio-economic characteristics, student perception of use of tablets, type of schoolbag, private tuition, performance, duration of bag carriage and anthropometric characteristics on musculoskeletal pain. Logistic regressions models were applied to inspect how those recorded factors contribute to the occurrence of musculoskeletal pain.

**Findings:** The main findings in this paper indicate that students from single-sexed girl and mixed schools relative to boys' schools, student perception of tablet use, backpack schoolbag relative to handbag and shoulder-bag, performance, total weight and excess weight of schoolbags have significant positive impact on musculoskeletal pain.

**Conclusion:** The results point towards the importance of raising awareness among students to achieve a positive musculoskeletal health. Information obtained is deemed to affect schoolbook and equipment-carrying behaviour and future choice of schoolbag type.

## Keywords:

## Introduction

Mauritius has embarked into a new education system since 2017 to remedy the inconveniences caused by past three education systems ranging from 'rat race' and enormous pressure on students to get best grades and A+ to secure seats in the star schools. This new system is intended to shape our students in the best possible ways so that they become future assets as human capitals in the competitive technological labor market. The government has set several objectives in the new education as shown in Table 1.

The key terms emerging from the six objectives of the NYCBE (Table 1) are 'knowledge, foundational skills, attitudes, moral responsibility, values, strong

identity, development, equitable learning, achievement, recognition, schooling, human capital and sustainable development. The objectives four, five and six are anchored on education and health issues in the Human Capital Theory (HCT). The HCT acknowledges early youth investments as influential in shaping future outcomes including high school graduation, post-secondary enrolment, employment, health, income and wealth. It gives importance to skills or abilities to lifetime success, health outcomes<sup>[1]</sup>, marriage, fertility, social cohesion, immigrant assimilation, entrepreneurship and criminal behavior<sup>[2]</sup>.

This study probed deeper in the HCT and investigates on the determinants of MusculoSkeletal Pains (MSP). A survey was

**Table 1)** Nine Year Continuous Basic Education (NYCBE) Objectives

1- Equip all students with knowledge, foundational skills and attitudes leading to an empowered 2030 citizenry.
2- Inculcate in all students a sense of moral responsibility, a set of values and a strong identity for the country.
3- Promote the holistic development of all students.
4- Provide equitable learning for all opportunities to attain high levels of achievement.
5- Achieve a smooth transition to and completion of secondary education.
6- Give greater recognition to the value of Technical and Vocational Education and Training (TVET) in building human capital and for sustainable development.

(Source: Author’s own)

performed and the quantitative ordered logistic regression models were used to expose the results. The findings may help to identify risk factors and isolate students prone to MSP and recommendations may help towards achieving a healthier and more productive future. The research question in this investigation was: “What are the factors causing MSP among students?”

In this regard, this study examined the prevalence and factors associated with MSP among secondary school students. It helped make proposals in the NYCBE so that MSP does not become a handicap to the learning and development of our future human capital. Therefore, for the holistic development of all students and an empowered citizenry on 2030, the study of the factors which contribute to pain among children is important. In this regard, the associated factor with MSP are discussed as follows.

**Age and MusculoSkeletal Pains**

Age is a possible demographic factor that can explain the occurrence of pain in general [3]. It has been revealed that MSP is diagnosed even in childhood. Moreover, both the prevalence and incidence of Back Pain (BP) increase with age [4]. Numerous studies bear testimony that the occurrence of neck or shoulder complaints [5, 6] and BP amplifies with age [7]. Females diagnose and

report their symptoms more sensitively than males [8]. In contrast, some previous researches revealed no connection between neck, shoulder or low back complaints and age but a weaker relation between age and Neck Pain (NP) [9, 10].

**Gender and MusculoSkeletal Pains**

MSP is generally more prevalent in females than males. This trend can be already present in childhood [11] and persists up to adulthood [12]. Both age and gender explain the presence of Lower Back Pains (LBP). For example, Dorsal Pain (DP) and LBP is more likely in girls of age 14 than boys of the same cohort [7]. It has been argued that MSP prevalence varies among adolescents and many studies reports females as being more susceptible to such pains [13, 9].

**Location and MusculoSkeletal Pains**

Geographical location denotes to the place where a school is situated whereas location is a particular place about other areas [14]. Therefore, the site of school is either urban or rural in our local context. The factor ‘student location’ may have an impact on pain intensity as it is related to walking and duration of bag carriage [15]. Studies report conflicting statistics on whether urban or rural locations can enhance pain intensity [16, 17]. Some studies indicate no significant relations between location and MSP [18], location and spinal pain [19], location and BP [20].

### Parental Education, Family Income and MusculoSkeletal Pains

Socio-economic deficiencies are related to poor health among students <sup>[21]</sup>. However, its connection to MSP is debatable. Previous study approved that low parental educational is an indicator of the socio-economic status of the family and is associated with LBP in children and adolescents <sup>[22]</sup>. Similarly, an existed study shows that parental education is an explanatory factor of MSP in school going children and it also impacts daily life <sup>[23]</sup>. A modest negative association can exist between parental education and LBP in young students <sup>[24]</sup>.

### Tablet (e-book) and MusculoSkeletal Pains

With the current technological developments, there is a change from old-style education to the tablet-assisted learning environment <sup>[25, 26]</sup>. Accordingly, a secondary school manages to replace heavy schoolbags full of textbooks with apple's lightweight tablet device, the iPad with the help of parents and teachers. Furthermore, e-books relief students from holding the heavy bags that may cause BP or spine bend <sup>[27]</sup>. Other studies indicate many physical discomforts associated with tablet use including MSP in many regions of the body <sup>[25, 28]</sup>.

### Type of Backpack and Musculoskeletal Pains

The type of school bags including backpacks, shoulder bags or handbags can boost discomfort in students in their sensitive growth and development period <sup>[29]</sup>. The way in which the backpack is carried and its model correlate with postural risks and BP in adolescents <sup>[30]</sup>. Carrying a bag over one shoulder brings postural changes which are in turn linked to spinal pain. There is an indication that a backpack is a healthier technique of carrying weight than a shoulder bag. One study indicates no association between the use of backpack and the occurrence of LBP <sup>[31]</sup>.

### Tuition and Musculoskeletal Pains

In today's competitive world, tuition brings additional weight to backpacks with additional items like books <sup>[32]</sup> and hence such students are more prone to MSP <sup>[33]</sup>. A fresh study shows that children are expected to experience neck and SP, as well as the commonly-reported BP. Tuition can also have an indirect impact on a student's health as it requires extra fees and some students are compelled to work part-time jobs to fit the budget. An evidence illustrates this outlier case whereby the respective student suffers from chronic illness due to a part-time job to pay the tuition fee even after graduation <sup>[34]</sup>.

### Performance and Musculoskeletal Pains

The performance of students and the occurrence of MSP depend on the subject being examined. Subjects like sports and physical education involve effort, spinal mobility and flexibility of muscles and joints and so they are associated with LBP <sup>[35]</sup>. A previous study indicated an association between procedure performance and musculoskeletal NP and BP in dental students <sup>[36]</sup>. According to an existed study <sup>[37]</sup>, in all the grades, more than half of the students present postural changes or pain in the academic performance of their school functions. An evidence indicates that high performance of students is linked with decreased BP, NP and SP as these students are less stressed <sup>[38]</sup>.

### BMI and Musculoskeletal Pains

Body Mass Index (BMI), which is a measure of body adiposity and is described as the weight (in kilograms) divided by height (in square meters), is also known to be related to the development of MSP <sup>[39]</sup>. It has been argued that BMI, stress and MSP's are interrelated <sup>[40]</sup>. Anthropometric measurements, weight and height, are carried out to assess BMI study <sup>[41]</sup>. One study measures BMI based on US references and groups BMI as underweight (<5%), normal weight (5%–<85%), overweight

(85%–<95%), and obese ( $\geq 95\%$ ) and finds that higher BMI is significantly associated with LBP in males and female students [42]. A previous research indicates BMI is an explanatory factor of BP in children between 8 and 13 years old [41]. There are also contrasting studies showing no such association between BMI and MSP [43].

### **Duration of school bag carriage**

Clinicians are frequently requested for instruction on school bag carriage and its contribution to back and neck pain [44]. The physical exposure of bag use is determined by its weight and also by the duration and method of carriage. Previous research revealed that a longer duration of carrying a school bag increases the risk of BP [45]. Risk factors for musculoskeletal agony are connected with the duration of schoolbag carriage combined with effects of hefty loads, load shape, size and location of the load on the body [46]. The presence of extensive weight burden on the back and its long duration of carriage has been resulted in first signs of the lower back pain syndrome [47]. Students carrying heavy backpacks from home to school on walking increase their relative risk of BP.

### **Length of straps**

Walking with a bag makes use of muscle activities including right upper trapezius, left upper trapezius, right erector spinae and left erector spinae. The length of straps may impact these muscle activities. The difference of straps length is seen to have significant influence on body posture [48]. A previous evidence finds no significant correlation between these activities and the length of straps of bags [49]. Still, some studies are in favor of two straps bags relative to one strap as it is believed to be ergonomic [50,51].

### **Weight and Excess Weight**

Schooling coincides with the sensitive growth periods of students and musculoskeletal changes [52]. The amount of schooling

materials that students carry is almost the same per grade but differs across grades. The weight of students varies greatly due to many reasons including age and genetics. This exposes students to many health issues, mainly MSP [53]. The recommended bag pack weight by health organizations diverges ranging from not exceeding 5 % to 20% of the student's body weight [54] but the most convincing figures is not to exceed 10% of their body weight [55]. Heavy bag packs are in turn associated with MSP [56].

### **Method and Materials**

The government manages public or state schools and the selection criteria included respondents who were students from secondary schools in Mauritius. On overall, all possible types at student and school levels were included in the research survey. The rectors of state schools and managers of private schools occupy the highest position within the school. Permissions were granted from the respective school's rectors and managers to conduct the surveys on students with age group varying from 11 to 18 years old. Each student was free to participate in the survey and they had the choice to answer or leave any question unanswered and even leave the survey at any moment.

The analysis and detection of musculoskeletal symptoms of different persons in different parts of the globe using indirect methods (questionnaires) require the standardization of the evaluation questions [57]. Therefore, a questionnaire that has been developed and it is widely used under the name of the Nordic Musculoskeletal Questionnaire (NMQ) was used [58]. Studies in MSP usually adapts from this standardized Nordic Questionnaire with modification to facilitate the comparison of results with other results in literature [59].

The first section of this questionnaire includes questions regarding socio-economic indicators and the second section deals with



English performance and school facilities (student's perceptions of the use of a tablet to replace books and private tuition). Section D is on health status captures anthropometric measures (height and weight of students), weight of bags, type of bags, length of bag straps, symptoms of potential musculoskeletal injuries and duration of bag carriage. A pen was given as a token to a student after completing the study. The mode of transportation was not included in the model because most students use free public bus transport compared to private, making further analysis unnecessary. The level of significance was set at  $p < 0.01$  at most.

There are various examples of studies using OLS techniques in the study of MSP in student [9,43]. It is always wise to have a notion of the statistical technique being utilized for practical usage and reliable results. A set of regression coefficients predicting the probability of MSP can be estimated by the use of logistic regressions.

### Data Collection

Out of the 2010 students requested to participate in the study, parental consent was obtained by 913 of them and 896 questionnaires were collected but due to incompleteness and bias because some respondents reported figures such as Rs 25.00 with respect to tuition fees. These values do not fit the actual context for private tuition. A few bag weights were written as 2 -5 grams instead of kilograms and they were omitted. Any flawed or partial responses were excluded from the final dataset. In this regard, 47 questionnaires were discarded. Therefore, the final sample size contains 849 questionnaires. Height was measured to an accuracy of 0.5 cm using a meter rule, and standing height was measured with the student shoes to avoid reluctance in participation. Body and schoolbag weight were measured with electronic balances with an accuracy of  $\pm 0.1$  kg. To ensure reliability

of the protocol, the weight measurements were taken on the same day and by the same investigator, and the average value out of three measurements was recorded. Each student's BMI was estimated in  $\text{kg/m}^2$ , and the relative schoolbag weight was estimated as a percentage of student weight (% of Body Weight). The time spent in carrying school bags were recorded in minutes and it accounts only in standing and walking positions. The students were notified that they can withdraw from the survey at any stage of the study

### Findings

Totally 849 students filled out the questionnaires completely. Of these studied students, about 89% of the overall students interviewed had MSP and a 3-point Likert-scale has been used to construct MSP indices. The average age in the sample was 14.5 years and the sample were roughly divided into three categories i.e. boys (49%), girls (23%) and mixed (28%) secondary schools. Most of the students were from rural regions, accounting for about 71% of the sample. About 70% of the parents possessed at least a secondary level education. About 30.6% were from middle-income earners (Level 2 and Level 3) while 74.1% were strongly in favour of replacing some books with e-books. The majority of the students (86.3%) used backpack type of schoolbag relative to others (e.g. shoulder bag and hand bag). About 58% of the students took private tuition while the mean English score was 49.2. The mean body mass index (BMI) was 20.3, revealing an average normal weight. Overall, students carried their bags for 55.02 minutes per day. Mean length of strap and weight of bag were 56.6cm and 4.4 kg respectively. Finally, about 29% of the studied students had excess bag weight. An overall logistic regression model was used to examine pain occurrence, irrespective of

the region. The  $R^2$  for the total was found to be around 0.14. It demonstrates that the model is relatively satisfying since it is between 0 and 1. For  $R^2$  to rise, there should be an increase in sample size.

Regarding gender, girls' more than boys were significantly more likely ( $p < 0.01$ ) to experience overall MSP. The results for gender and its association with pain is supported by literature whereby females are more likely to experience pain compared to males [7]. The marginal effects in models 1 and 2 suggest that an increase in the number of girl's students' in schools is associated with around 16% -17% more likely to experience the presence of pain. A similar effect was seen even in mixed schools as it was composed of girls and boys who might be related to the female composition. Thus it is suggested that females diagnose, state and report their symptoms are more sensitively than males [8].

This study showed that an increase in mother's education level causes an increase in student's MSP and tertiary education is the most significant ( $p < 0.01$ ). The marginal effects indicate that an increase in mother's tertiary education level is linked to around 2% more likely MSP report in students. For the question of parental literacy level, the results indicate mother's education levels have more significant impacts on pains in general compared to father's education levels consistent with a recent finding [20].

The student's perception of replacing books with tablets has a significant positive impact on MSP implying that students having MSP are more likely to opt for tablets. Such a perception matches with literature where carrying e-textbooks on a lightweight device is better than being burdened with the added weight of paper-based books [26].

English performance is positively and significantly linked with MSP, and marginal indicates that an increase in performance

is associated with about 2% more likely MSP in students. The result tallies another study which whereby performance is linked to overall body pains [37]. A possible explanation for such pains is academic pressure and psychological pressure about the approaching exams and the reduction of physical activity caused by the academic burden [38].

The duration of school bag carriage positively impacts MSP ( $p < 0.05$ ). It is likely that the risk factors for musculoskeletal agony are connected with the duration of school bag carriage combined with effects of heavy loads, load shape, size and location of the load on the body [17].

Bag weights relative to body weight positively affect MSP, and it increases as weight increases. The marginal effects in models 1 and 2 indicate that an increase in the weight of bags is associated with around 1% more likely to experience overall pain with normal weight and around 2% more likely pain with an increase of excess weight. In this study overall pains were observed even below 10 % of body weight and the intensity of pains increases linearly with excess percent of body weight as illustrated in many independent researchers [47, 56].

## Discussions

The research question in this investigation was as: What are the factors causing MSP among students? . Accordingly, the findings of the study showed that the demographic factor of age did not show any association between neck, shoulder and lower back (NSLB) complaints that is in line with the results of one previous study [9]. The results for gender and its association with pain confirmed literature whereby females were more likely to experience pains compared to males. According to literature, female students are more susceptible to BP. A plausible explanation for males experiencing

less LBP is their physical fitness with stronger muscles. Under the NYCBE curriculum, the introduction of woman -core subjects like oral expression may help the pain reporting differences between boys and girls [8]. The disparity in physical fitness between boys and girls may fade by emphasizing the implementation of practical physical education and health programs mainly in girl's school.

This study displayed no significant association between residency location and MSP which is in agreement with some previous studies on students [19, 20]. Under the NYCBE, maintaining the provision of free transport services alongside with the zoning systems may be helping students to avoid MSP. Previous study showed that socio-economic deficiencies are related to poor health among students [21]. For the question of parental literacy level, the results indicated mother's education levels have greater impacts on pains in general compared to father's education levels consistent with a recent finding [12].

This study significantly indicated that students who feel MSP prefer to switch to a tablet. Such a perception matches with literature whereby carrying e-textbooks on a light appliance is better than being loaded with the extra weight of traditional paper books [26]. However, it seems that students are willing to experience this innovation, and they are naïve with respect to many physical discomforts associated with tablet use including MSP in many regions of the body [25,28]. The NYCBE needs to highlight the pros and cons associated with tablet use.

The models revealed that the academic performance of students is associated with overall body pains as indicates additional research [37]. A possible explanation for such pains is academic pressure and psychological pressure in relation due to the approaching exams and the reduction

of physical activity caused by the academic burden [38]. Workshops and seminars on musculoskeletal education involving students, parents and educators require due attention in the NYCBE program.

Tuition was not associated with MSP in Mauritius which was in contradiction with the notion of heavy tuition books and hard work displayed by these two previous studies [33,34]. No association was seen between BMI and pains and similar results are reported by some studies in this regard [9, 43].

The duration of bag carriage was directly associated with pains in various regions of the body and revealed to be a significant explanatory variable. Acceding to previous study, a longer period of carrying a school bag may increase the risk of adolescent BP [15]. It is likely that the risk factors for MSP are connected with the duration of schoolbag carriage combined with effects of heavy loads, load shape, size and location of the load on the body [46].

In this study, the length of straps was not associate with pains measured that was similar to previous research [49]. Overall pains are observed even below 10 % of body weight and the intensity of pains increases linearly with excess this percent of body weight as illustrated in many independent types of research [47, 56]. In both cases, strong shoulder BP arises which may be due to an uneven distribution of load on the shoulders. Perhaps, education stakeholders will have to consider the 5% student's body weight [54].

## Conclusion

The investigation of the prevalence and factors associated with MSP indicate that students from single-sexed girl and mixed schools relative to boys' schools, student perception of tablet use, backpack schoolbag relative to handbag and shoulder-bag, performance, duration of bag carriage, total weight and excess weight of

schoolbags have significant positive impact on musculoskeletal pain. Musculoskeletal education by expert physicians is highly recommended to all students and educators so that there is cohesion between physical education, student health and academic performance.

Health can impact academic performance, and therefore it should be the concern of the legal system to guarantee it to its population. Under the curriculum, the use of tablets to replace some books may contribute to decreasing the bag weights, and the use of term wise books as it is the case in grades 1 to 6 should be extended to higher grades. The availability of lockers at schools may bring relief to students from both normal weight and excess weight of bags and associated MSP. Long waiting time on bus stops with heavy bags should be avoided by proper management of the free transport services. Future work on the prevalence and factors associated with MSP among secondary school students can be reproduced with larger sample sizes by including other secondary schools. It is worthy to use lower grades students from primary schools and tertiary level students to have a better comprehension of the correlation between ages, bag weight, performance and MSP. For instance, the study does cater for measurements in pain intensity which is crucial in policy implication. Thus, future work can identify ways to evaluate the impact of pain using multidimensional pain scales.

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**Authors' contribution:** NS designed and performed the study and wrote the manuscript. JV participated in designing the study and supervised it. Both authors confirmed the

manuscript.

**Conflict of Interest:** There is no conflict of Interest for this study

### Ethical Permission:

All ethical principals were considered in this study. The rectors of state schools and managers of private schools occupy the highest position within the school. The aim and procedures of the study were explained to the them. Permissions were granted from the respective school's rectors and managers to conduct the surveys on students with age group varying from 11 to 18 years old. Each student was free to participate in the survey and they had the choice to answer or leave any question unanswered and even leave the survey at any moment.

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