Research Report

‘An Investigation of the Physical and Psychosocial Factors of Schoolbag Carriage Among Irish Post-Primary Schoolchildren.’

Word Count: 3025

Key Words: Schoolbag Weight; Musculoskeletal Discomfort; Percentage of Body Weight Carried; Psychosocial Factors; Post-Primary Schoolchildren.
**Background:** Schoolbag carriage is a daily activity for children. In Europe, the recommended guideline for children is <10% body weight (BW). This is rarely adhered to. The purpose of this study is to investigate schoolbag related musculoskeletal discomfort (MSKD) in Irish first year post-primary schoolchildren and to gain insight into psychosocial influences that might be involved.

**Methods:** A post-primary school in County Kildare was investigated. Children were issued a Body Discomfort Chart (BDC), to assess ‘baseline’ MSKD, and a Strengths and Difficulties Questionnaire (SDQ) prior to data collection day. On data collection day, MSKD was assessed on arrival at school using another BDC, height and weight were recorded and an Author-assisted Questionnaire (AAQ) completed.

**Results:** Data of 100 children were included. Mean percentage body weight (%BW) carried was 14.24% (±4.82). The majority carried a backpack (93%) over both shoulders (95%) for <10 minutes. The prevalence and intensity of MSKD significantly increased after schoolbag carriage (p=0.000). At all pain recording intervals, the shoulder complex was the main area of MSKD. Of those who experienced MSKD in the past month, 71.2% (n=52) felt that it was schoolbag related. These children carried significantly more %BW than those that did not feel that their MSKD was schoolbag related (p=0.000). Abnormal emotional wellbeing was found to increase the incidence of low back pain (LBP).

**Conclusion:** The recommended guideline is exceeded. Longer durations of schoolbag carriage increase MSKD. The shoulder complex consistently proves to be the main area of MSKD, followed by the back. Emotional wellbeing influences LBP. Higher levels of physical activity appear to have a protective mechanism against pain. Future investigations should continue to address the site and intensity of MSKD, as well as psychosocial factors. This pilot study has the potential to developed in other post-primary schools across Ireland, so findings can be extrapolated.
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2. List of Abbreviations

BW = Body Weight
MSKD = Musculoskeletal Discomfort
%BW = Percentage of Body Weight
LBP = Low Back Pain
R1 = Researcher One
R2 = Researcher Two
R3 = Researcher Three
R4 = Researcher Four
SDQ = Strengths and Difficulties Questionnaire
BDC = Body Discomfort Chart
VAS = Visual Analogue Scale
AAQ = Author-Assisted Questionnaire
SPSS = Statistical Package of the Social Sciences
3. Abstract (Repeated, as per submitted in college, so page numbers remained correct)

Background: Carrying a schoolbag is a daily activity for many Westernised children. In Europe, there is a recommended guideline for children to carry <10% body weight (BW). However, this is rarely adhered to. There is concern regarding the excessive loading of the developing musculoskeletal system and the development of musculoskeletal disorders. The purpose of this study is to investigate schoolbag related musculoskeletal discomfort (MSKD) in Irish first year post-primary schoolchildren and to gain insight into psychosocial influences that might be involved.

Methods: A convenience sample was investigated in a post-primary school in County Kildare in March 2013. Children were issued with a Body Discomfort Chart (BDC), to assess ‘baseline’ MSKD, and a Strengths and Difficulties Questionnaire (SDQ) prior to data collection day. On data collection day, MSKD was assessed on arrival at school using another BDC, height and weight were recorded and a 27-item Author-assisted Questionnaire (AAQ) was completed. If pain was experienced in the last month, a third BDC was completed.

Results: Data of 100 children were included in the analysis. Mean schoolbag weight was 7.37kg (±2.17) and mean percentage body weight (%BW) carried was 14.24% (±4.82). The majority carried a backpack (93%) over both shoulders (95%) for <10 minutes. The prevalence and intensity of MSKD significantly increased after schoolbag carriage (p=0.000). At all pain recording intervals, the shoulder complex was the main area of MSKD. Of those who experienced MSKD in the past month, 71.2% (n=52) felt that it was schoolbag related. These children carried significantly more %BW than those that did not feel that their MSKD was schoolbag related (p=0.000). Overweight children sought significantly more medical attention for pain in the last month (p=0.029). Abnormal emotional wellbeing was found to increase the incidence of low back pain (LBP).

Conclusion: Irish schoolchildren exceed the recommended guideline of <10%BW. Longer durations of schoolbag carriage increase MSKD. The shoulder complex consistently proves to be the main area of MSKD, followed by the back. Emotional wellbeing influences LBP. Higher levels of physical activity appear to have a protective mechanism against pain. Future investigations should continue to address the site and
intensity of MSKD, as well as psychosocial factors. This pilot study has the potential to developed in other post-primary schools across Ireland, so findings can be extrapolated.

4. Introduction
Carrying a schoolbag is considered a daily 'occupational' load for schoolchildren in Western countries (Negrini and Carabalona 2002). This everyday activity imposes considerable load on the developing musculoskeletal system. Rateau (2004) suggests that the repetitive and frequent use of schoolbags can potentially pose a negative cumulative effect on posture, gait and global mobility.

Lower back pain (LBP) among children is almost as prevalent as it is in adults (Burton et al 1996; Troussier et al 1994). LBP will be experienced by 80% of people in their lifetime (Walker 2000), with Grimmer and Williams (2000) reporting that the prevalence in adolescents is at 50% already. It has been established that childhood back pain increases the likelihood of experiencing back pain as an adult (Cottalorda et al 2004).

Negrini et al (1998) reported schoolbag load as a risk factor for developing LBP in childhood. Whittfield et al (2001) concurred that heavy schoolbags combined with long carriage durations can lead to childhood musculoskeletal disorders. Schoolbag weight, type, method and duration of carriage have previously been investigated. However, musculoskeletal disorders are known to be multifactorial in nature. Psychosocial factors are known to be influential in musculoskeletal disorders in adults (Moore 2010; Cimmino et al 2011), but have yet to be thoroughly investigated in children. Van Gent et al (2003) found a strong relationship between psychosomatics factors and the occurrence of neck, shoulder and back complaints in young adolescents. Trevelyan and Legg (2006) also highlight low physical activity, prolonged sitting and computer use as risk factors for the development of musculoskeletal problems in children that warrant further investigation.

In 1977, Voll and Klimt proposed a general guideline for the weight of schoolbags to be <10% of the child's body weight (BW). Hong et al (2000) found that children that who carried ≤10%BW had no significant change in their cardiovascular system or gait
pattern. Authors have found adverse physiological and biomechanical effects when 10%BW is exceeded. Hong et al (2000) and Lai and Jones (2000) reported an increase in kyphotic posture and a decrease in lung capacity. Chansirinukor et al (2001) found that children who carried >15%BW had a negative influence on cervical and shoulder posture in standing. Wang et al (2001) noted increased trunk flexion and craniovertebral angle, coupled with an altered gait pattern when ≥20%BW was carried. Neuchwander et al (2011) found a decrease in disc height (particularly L4 and L5) using magnetic resonance imaging as schoolbag load increased.

The <10%BW is the accepted guideline across Europe, with Ireland no exception. An unpublished pilot study of Irish post-primary school students by Dockrell et al (2006) found that 68% of children exceeded this recommended guideline. In Ireland, there is particular concern for post-primary Junior Cycle students. At this age, the musculoskeletal system is at a pivotal point in development and there is the expectancy to carry many large books to meet the academic syllabus. Whittfield et al (2001) would agree that this is a vulnerable cohort, as smaller children are expected to carry the same load as larger children at this age. There has not been investigation in Ireland in this cohort since that of Dockrell et al (2006). The purpose of this study is to investigate the physical and psychosocial factors associated with schoolbag carriage among Irish post-primary schoolchildren.

5. Methodology
5.1 Aim
This study aims to investigate the physical and psychosocial factors that may be associated with schoolbag related musculoskeletal discomfort (MSKD).

5.2 Objectives
1. To establish the schoolbag weights and percentage of bodyweight (BW) carried by Irish post-primary schoolchildren.
2. To establish the perceived load of the schoolbags carried by Irish post-primary schoolchildren.
3. To establish the type, method and duration of schoolbag carriage by Irish post-
primary schoolchildren.
4. To establish the levels of MSKD associated with schoolbag carriage.
5. To investigate the relationship, if any, between physical activity, discomfort,
psychosocial factors and schoolbag carriage.
6. To compare the above findings between normal weight schoolchildren and
overweight schoolchildren.

5.3 Design
This was a cross-sectional study. Data was collected from a convenience sample of first
year post-primary schoolchildren by four researchers: researcher one (R1), researcher
two (R2), researcher three (R3) and researcher four (R4).

5.4 Ethical Approval
Ethical approval was granted by the Trinity College Dublin, Faculty of Health Sciences
Ethics Committee on 18th February 2013 (Appendix 1).

5.5 Samples and Participants
The initial post-primary school contacted by R1 via personal correspondence, agreed
immediately to participate in the study. An information pack and copies of the outcome
measures were sent electronically to the principal for his perusal (Appendix 2). The
principal confirmed his school’s participation via a telephone call with the supervisor.

No further schools were contacted, as the sample was large enough to make the study
statistically viable (n=144). The school targeted was a mixed cohort, with children
travelling by various means and distances to attend.

Information packs containing consent/assent forms (Appendix 3) were distributed in
person by R1. A brief outline of the study was given and any questions answered.
Contact information was provided should parents or children have any further questions. A seven-day 'cooling period' was given, to allow for an informed decision.

Only the children who had returned fully completed consent/assent forms and met the study's inclusion criteria participated. Children could withdraw from the study at anytime. A coding system was used to maintain confidentially. Data was electronically stored in a password-protected computer. Hardcopies of the data were stored securely in the supervisor's office.

5.5.1 Inclusion Criteria
- Must be in enrolled in first year mainstream post-primary school in Ireland.
- Must carry a schoolbag.

Schoolchildren in their first year post-primary were chosen as they are typically expected to carry the same weight as older, larger children. Schoolbag weight increases when children transition to post-primary school.

5.5.2 Exclusion Criteria
- Children unable to carry a schoolbag.
- Children unable to stand independently.

5.6 Measures
5.6.1 Strengths and Difficulties Questionnaire (SDQ)
Strengths and Difficulties Questionnaire (SDQ) (Appendix 4) measured the psychological wellbeing of the schoolchildren. The self-completion (11-17 years) version was used. The questionnaire asked about 25 attributes that captured information about five psychosocial areas; conduct issues, emotional symptoms, hyperactivity, peer problems and pro-social behaviour (Goodman 1997).

The SDQ has acceptable internal consistency, high inter-rater reliability and test re-test reliability (Goodman 2001; Muris et al 2003; Stone et al 2010).
5.6.2 Body Discomfort Chart (BDC) and Visual Analogue Scale (VAS)

The BDC (Appendix X) was the method used for measuring discomfort experienced by the children. Corlett and Bishop (1976) developed this measure. Children mark on human figures where they feel MSKD. Three VAS (100mm) are below these figures, where children rate the intensity of each MSKD.

Von Baeyer et al. (2011) found that recording pain on a BDC was more consistent or valid with final diagnosis then when pain was verbally reported. Both Harel et al. (1994) and Grimmer et al. (2000) report acceptable levels of validity and reliability of schoolchildren recalling recreational and non-fatal injuries in the last month.

5.6.3 Anthropometrics

A Stadiometer (SECA model 213) was used to measure height (Illustration 1). A reliability study between the researchers found R2 was the most reliable at recording height, thus measured the height of all participants.

A calibrated scale (Tanita HD 352) was used to recorded weight (Illustration 2). For reliability and consistency, R3 recorded all weights.

Body Mass Index (BMI) (kg/m²) was calculated using Statistical Package for the Social Sciences (SPSS) V20. BMI was then stratified using the International Obesity Task Force (IOTF) classification; healthy weight (<91st percentile), overweight (91st-98th percentile) and obese (>98th percentile) (Appendix 7) (Cole et al. 2000).
5.6.2 Author-assisted Questionnaire (AAQ)

The AAQ (Appendix 6) contained 27 questions that investigated features related to schoolbag carriage. The supervisor had previously piloted the AAQ. Grimmer and Williams (2000) had previously looked at similar features associated with schoolbag carriage and found them to be valid.

5.7 Procedure

R1 distributed SDQs and BDC(pre) the day before data collection. Clear instructions were given to fill out the BDC(pre) just before leaving for school. This was to establish ‘baseline’ MSKD. The SDQ was filled out at the child’s convenience. Data was collected on two consecutive days, owing to the size of the sample. The children came directly to the testing area on their allocated day.

Data collection was conducted in a circuit type format. At station one, R1 greeted each child, noted their attendance, issued a BDC(post), to be completed immediately, and an AAQ. Once BDC(post) was completed the child proceeded to station two where their height recorded by R2. Height was recorded in stocking feet. R2 issued standardised instructions to each child, “Stand up tall and look straight ahead”.

Illustration 1. Stadiometer (SECA model 213).  Illustration 2. Calibrated Scale (Tanita HD 352)
Weight was recorded in stocking feet at station three by R3. Weight was recorded without bags to establish BW and then weight was recorded with their schoolbag to establish schoolbag weight. If a child had any additional bags they were measured a third time with their schoolbag, plus any additional baggage. The child proceeded to the fourth station where R4 assisted them with completing the AAQ. This format was repeated the following day for the remainder of the sample.

5.8 Data Analysis

Data analysis was analysed using SPSS V20. Descriptive statistics, Cross-tabulation, Chi-squared statistics and Independent T-tests were used to analyse data. A significant relationship was indicated by p <0.05.

6. Results

6.1. Recruitment and Participation Rate

A description of the recruitment process can be viewed in Figure 1. The response rate was 76.4% (74.3% positive response). A total of 100 children were included in data analysis. thus n=100 unless otherwise stated.
6.2. Demographics and Anthropometric Values

There were no significant anthropometric differences between males and females (Table 1 and 2).
Table 1. Anthropometric Values of Participants.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total Mean (±SD)</th>
<th>Male Mean (±SD)</th>
<th>Female Mean (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Range</td>
<td>Range</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>12.96 (±0.37)</td>
<td>13.02 (±0.44)</td>
<td>12.91 (±0.30)</td>
</tr>
<tr>
<td></td>
<td>12 - 14</td>
<td>12 - 14</td>
<td>12 - 13</td>
</tr>
<tr>
<td>Weight (Kilograms)</td>
<td>53.24 (±10.21)</td>
<td>54.04 (±11.84)</td>
<td>52.50 (±8.56)</td>
</tr>
<tr>
<td></td>
<td>34.4 - 98.2</td>
<td>37.4 - 98.2</td>
<td>34.4 - 69.0</td>
</tr>
<tr>
<td>Height (Centimetres)</td>
<td>161.95 (±6.94)</td>
<td>163.03 (±6.73)</td>
<td>161.04 (±7.04)</td>
</tr>
<tr>
<td></td>
<td>144.3 - 177.8</td>
<td>145.9 - 177.8</td>
<td>144.3 - 174.4</td>
</tr>
<tr>
<td>BMI</td>
<td>20.19 (±2.94)</td>
<td>20.21 (±3.41)</td>
<td>20.17 (±2.56)</td>
</tr>
<tr>
<td></td>
<td>15.52 - 31.6</td>
<td>15.52 - 31.06</td>
<td>15.96 - 26.03</td>
</tr>
<tr>
<td>SDQ Total Score</td>
<td>9.29 (±4.789)</td>
<td>9.34 (±4.87)</td>
<td>9.25 (±4.76)</td>
</tr>
<tr>
<td></td>
<td>0 - 26</td>
<td>0 - 23</td>
<td>1 - 26</td>
</tr>
</tbody>
</table>

Table 2. Breakdown of SDQ classification & BMI classification.

<table>
<thead>
<tr>
<th>SDQ Total Score Code</th>
<th>Total n (%)</th>
<th>Male (n)</th>
<th>Female (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>84 (84%)</td>
<td>39 (39%)</td>
<td>45 (45%)</td>
</tr>
<tr>
<td>Borderline</td>
<td>8 (8%)</td>
<td>3 (3%)</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>8 (8%)</td>
<td>5 (5%)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>BMI IOTF Classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy Weight</td>
<td>83 (83%)</td>
<td>38 (38%)</td>
<td>45 (45%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>11 (11%)</td>
<td>4 (4%)</td>
<td>7 (7%)</td>
</tr>
<tr>
<td>Obese</td>
<td>6 (6%)</td>
<td>5 (5%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>BMI 2 way Class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy Weight</td>
<td>83 (83%)</td>
<td>38 (38%)</td>
<td>45 (45%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>17 (17%)</td>
<td>9 (9%)</td>
<td>8 (8%)</td>
</tr>
</tbody>
</table>

6.3 Schoolbag Weight & %BW
A breakdown of the mean schoolbag weights, additional baggage weight and %BW carried is shown in Table 3. A total of 82% carried greater than the 10%BW recommendation (Figure 2).

Additional baggage was carried by 29% of the sample. Males were more likely to carry additional baggage than females (p=0.005).

Those who reported pain before carriage were more likely to carry >10%BW (p=0.042). Also those who reported pain in the last month were more likely to carry >10%BW (p=0.0003).
Table 3. Mean & Range: Schoolbag Weight, Additional Weight, %BW.

<table>
<thead>
<tr>
<th></th>
<th>Mean (±SD)</th>
<th>Mean Male (±SD)</th>
<th>Mean Female (±SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schoolbag Weight (kg)</td>
<td>7.37 (±2.17)</td>
<td>7.5 (±2.58)</td>
<td>7.25 (±1.73)</td>
<td>1.2-12.5</td>
</tr>
<tr>
<td>Additional Baggage Weight (kg)</td>
<td>2.86 (±1.06)</td>
<td>3.25 (±1.03)</td>
<td>2.22 (±0.79)</td>
<td>1.0-5.0</td>
</tr>
<tr>
<td>%BW of Schoolbag</td>
<td>14.24% (±4.82)</td>
<td>14.37% (±5.63)</td>
<td>14.13% (±4.02)</td>
<td>2.5% - 28.2%</td>
</tr>
<tr>
<td>%BW of Schoolbag &amp;</td>
<td>19.5% (±5.00)</td>
<td>19.6% (±5.70)</td>
<td>18.4% (±1.13)</td>
<td>9.2% – 31.4%</td>
</tr>
<tr>
<td>Additional Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Percentage of Body Weight carried by the Sample (n=100).

6.4 Perceived Load

The perception of schoolbag weight is shown in Figure 3. (89 children answered this question).

Schoolbag weights were correctly perceived by 41.6% (n=37). Neither sex was significantly superior at estimating schoolbag weight.
If the schoolbag was perceived as heavy the child was more likely to report pain before carriage (p=0.001). Similarly a higher intensity was recorded on the VAS before carriage, if the bag was perceived to be heavy (p=0.002).

![Figure 3. Perception of Schoolbag Weight.](image)

### 6.5 Schoolbag Type, Method of Carriage, Duration and Mode of Transport

#### 6.5.1 Type of schoolbag and method of carriage
The majority carried a backpack (n=93), while the remainder used a shoulder bag (n=7). The use of both shoulders was the most popular method to schoolbag carriage (n=95), the rest carried their bag on one shoulder.

#### 6.5.2 Duration of Carriage and Mode of Transport
The majority 74.3% (n=74) carried their bags for a relatively short period of time, <10 minutes (Table 4). There is a trend for children to carry their schoolbags for longer going home from school (Table 5).
Table 4. Mode of Travel to School vs. Duration of Schoolbag Carriage To School.

<table>
<thead>
<tr>
<th>Mode of travel to school</th>
<th>Duration of schoolbag carriage to school</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5 mins</td>
<td>5-10 mins</td>
</tr>
<tr>
<td>Walk</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Car</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Bus/train</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 5. Mode of Travel from School vs. Duration of Schoolbag Carriage to School.

<table>
<thead>
<tr>
<th>Mode of travel from school</th>
<th>Duration of schoolbag carriage from school</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5 mins</td>
<td>5-10 mins</td>
</tr>
<tr>
<td>Walk</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Car</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Bus/train</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>31</td>
</tr>
</tbody>
</table>

6.6 Levels of MSKD Associated with Schoolbag Carriage

6.6.1 MSKD Before and After Carriage

Table 6 shows the characteristics of MSKD before and after schoolbag carriage. MSKD both before and after schoolbag carriage was experienced by 62% (n=62). Thus, 19 new cases of MSKD were reported after schoolbag carriage. There was a significant relationship between having pain before carriage and still experiencing it after carriage (p=0.000). There was no significant difference between reporting pain and gender or BMI (p>0.05). Shoulders, followed by back, were the main area of pain both before and after carriage (Figure 4).
Table 6. Characteristics of Pain; Before Carriage and After Carriage.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pain Before</th>
<th>Pain After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>66</td>
<td>81</td>
</tr>
<tr>
<td>Males</td>
<td>33</td>
<td>39</td>
</tr>
<tr>
<td>Females</td>
<td>33</td>
<td>42</td>
</tr>
<tr>
<td>Both before &amp; after carriage</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>Number of areas of discomfort</td>
<td>1.12 (±1.06)</td>
<td>1.46(±1.06)</td>
</tr>
<tr>
<td>Males</td>
<td>1.15 (±0.99)</td>
<td>1.47 (±0.95)</td>
</tr>
<tr>
<td>Females</td>
<td>1.10 (± 1.13)</td>
<td>1.46 (±1.16)</td>
</tr>
<tr>
<td>Main Anatomical Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Shoulders</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td>Arms</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Back</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Hips</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Knees</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Ankles &amp; Feet</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Mean Pain Intensity of Main Site</td>
<td>3.76 (±3.16)</td>
<td>4.57 (±3.04)</td>
</tr>
<tr>
<td>Male</td>
<td>4.04 (±3.17)</td>
<td>4.77 (±3.04)</td>
</tr>
<tr>
<td>Female</td>
<td>3.50 (±3.16)</td>
<td>4.40 (±3.29)</td>
</tr>
<tr>
<td>Those Who had Pain Before and After</td>
<td>3.85 (±3.15)</td>
<td>3.85 (±3.15)</td>
</tr>
</tbody>
</table>

The mean intensity of pain experienced before and after schoolbag carriage can be seen in Table 6. Intensity was greater after schoolbag carriage, however not significantly. Interestingly, males tended to report marginally higher levels of intensity than females (Figure 5).
Figure 4. Main Areas of Discomfort.

Figure 5. Mean Discomfort Intensity at Main Sites as Measured on VAS.

6.5.2 MSKD in the Last Month

The majority (73%) had MSKD in the last month (Table 7). Shoulders and back were the main areas (Figure 5). The mean intensity was 4.38(±3.32).

No significant difference was found between males and females. The same was found for BMI, with the exception of medical attention - those who were overweight tended to seek medical attention more than those of a healthy weight (p=0.029) (Appendix X). Pain in the last month did not significantly interfere with activities of daily living (p>0.05).
Of those who experienced pain in the last month, 71.2% (n=52) felt that their pain was schoolbag related. Those who carried a heavier schoolbag were more likely to report that MSKD was bag related. (p=0.000), (Table 8).

Table 7. Characteristics of MSKD in Last Month.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pain in Last Month</th>
<th>Bag-Related Pain in Last Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>73</td>
<td>52 (71.2%)</td>
</tr>
<tr>
<td>Males</td>
<td>36</td>
<td>25 (69.4%)</td>
</tr>
<tr>
<td>Females</td>
<td>37</td>
<td>27 (73.0%)</td>
</tr>
<tr>
<td>Number of areas of discomfort</td>
<td>1.20 (±1.00)</td>
<td>-</td>
</tr>
<tr>
<td>Males</td>
<td>1.30 (±1.04)</td>
<td>-</td>
</tr>
<tr>
<td>Females</td>
<td>1.12 (±0.98)</td>
<td>-</td>
</tr>
<tr>
<td>Main Anatomical Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Shoulders</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>Arms</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Back</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Hips</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Knees</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ankles &amp; Feet</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Mean Pain Intensity of Main Site</td>
<td>4.38 (±3.32)</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>4.64 (±3.39)</td>
<td>-</td>
</tr>
<tr>
<td>Female</td>
<td>4.16 (±3.32)</td>
<td>-</td>
</tr>
<tr>
<td>Frequency of Pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 time/month</td>
<td>17</td>
<td>-</td>
</tr>
<tr>
<td>2-3 time/month</td>
<td>22</td>
<td>-</td>
</tr>
<tr>
<td>1 time/week</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>2-3/week</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>Everyday</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Medical Attention; Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18%</td>
<td>-</td>
</tr>
<tr>
<td>No</td>
<td>82%</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 8. Profiles of Children with Bag Related vs. Non-Bag Related MSKD in the Last Month.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Discomfort related to schoolbag @ 1 month</th>
<th>Discomfort not related to schoolbag @ 1 month</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>160.54 (±0.56)</td>
<td>161.35 (±1.06)</td>
<td>p=0.461</td>
</tr>
<tr>
<td>Height</td>
<td>161.35 (±0.87)</td>
<td>163.51 (±1.41)</td>
<td>p=0.125</td>
</tr>
<tr>
<td>Weight</td>
<td>52.34 (±9.98)</td>
<td>55.38 (±2.60)</td>
<td>p=0.264</td>
</tr>
<tr>
<td>BMI kg/m²</td>
<td>20.09 (±0.43)</td>
<td>20.56 (±0.70)</td>
<td>p=0.549</td>
</tr>
<tr>
<td>Schoolbag Weight</td>
<td>8.03 (±0.27)</td>
<td>6.12 (±0.40)</td>
<td>p=0.000*</td>
</tr>
<tr>
<td>%BW of Schoolbag</td>
<td>15.92 (±0.68)</td>
<td>11.14 (±0.65)</td>
<td>p=0.000*</td>
</tr>
<tr>
<td>SDQ Total</td>
<td>9.83 (±0.72)</td>
<td>9.13 (±0.90)</td>
<td>p=0.573</td>
</tr>
<tr>
<td>Positive History of Family LBP</td>
<td>72.7%</td>
<td>27.3%</td>
<td>p=0.434</td>
</tr>
</tbody>
</table>

6.7 Relationships between MSKD, Physical Activity, Psychosocial Factors and Schoolbag Characteristics.

6.7.1 MSKD and Physical Activity

Figure 6. shows the relationship between MSKD and physical activity.

Play Sport (n=98):
- MSKD/Intensity Before Carriage = 66.3%/3.75±3.14
- MSKD/Intensity After Carriage = 82.5%/4.59±3.15
- MSKD/Intensity in Last Month = 72.4%/4.33±3.34

TV/Video/Computer (n=95):
- MSKD/Intensity Before carriage = 67%/3.74±3.12
- MSKD/Intensity After Carriage = 81.9%/4.59±3.15
- MSKD/Intensity in Last Month = 72.6%/4.39±3.34

Carrying a schoolbag significantly increased MSKD (p=0.000).
- Pain intensity significantly increased after schoolbag carriage (p=0.000).
- Greater hours playing sport resulted in less MSKD being reported (p=0.033).
- Those who played more hours of sport reported lower pain intensities (p=0.002).

Carrying a schoolbag significantly increased MSKD (p=0.000).
- Pain intensity significantly increased after schoolbag carriage (p=0.000).
- No other significant relationships are observed between TV/Video/Computer and Discomfort.

Figure 6. Relationship between MSKD and Physical Activity.
### 6.7.2 Discomfort and Psychosocial Factors

Figure 7 shows the relationship between MSKD and psychosocial factors.

**Figure 7. Relationship between MSKD and Psychosocial Factors.**

<table>
<thead>
<tr>
<th>SCQ Score:</th>
<th>Means for each section of SDQ:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (84%)</td>
<td>Emotional Wellbeing 2.61 (± 1.77) - Normal</td>
</tr>
<tr>
<td>Borderline (8%)</td>
<td>Conduct 1.41 (± 1.47) - Normal</td>
</tr>
<tr>
<td>Abnormal (8%)</td>
<td>Hyperactivity 4.07 (± 2.04) - Normal</td>
</tr>
<tr>
<td></td>
<td>Peer Problems 1.19 (± 1.57) - Normal</td>
</tr>
<tr>
<td></td>
<td>Prosocial Behaviour 7.85 (± 1.73) - Normal</td>
</tr>
</tbody>
</table>

An abnormal score on the Emotional Wellbeing section of the SDQ was found to have a significant relationship with reporting LBP before Schoolbag carriage (p=0.002).

45% had a Family History of LBP, of which:
- MSKD before carriage = 64.4%
- MSKD after carriage = 80%
- MSKD in the last month = 66.7%

No significant relationship was found between pain reporting and a family history of LBP.

### 6.7.3 Discomfort and Schoolbag Characteristics

Figure 8 depicts the relationship between discomfort and schoolbag characteristics.

**Figure 8. Relationship between MSKD and Schoolbag Characteristics.**

- Backpacks (93%), Shoulderbags (7%)
- Method of Carriage: Shoulders x2 (95%)
- Shoulders x1 (5%)

- Children were more likely to report MSKD before carriage if the duration of schoolbag carriage on the journey to school was longer, not significantly (p=0.058).
- The longer the child had to carry their schoolbag to school the greater the intensity of the pain reported (p=0.016).

- The length of time spent carrying a schoolbag from school was significantly related to experiencing pain in the last month (p=0.029). This may signify a cumulative effect of prolonged schoolbag carriage returning home from school.

- The heavier the %BW carried by the child, the greater the likelihood that they will report pain after carriage (p=0.022).
### 6.8 Healthy Weight Children vs. Overweight

Figure 9. shows differences between healthy weight and overweight children.

<table>
<thead>
<tr>
<th>Healthy Weight Children</th>
<th>Overweight Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference in mean bodyweight: 17.76kg.</td>
<td>Mean schoolbag weight was 0.99kg more for overweight children.</td>
</tr>
<tr>
<td>Overweight children were on average 2.18cm taller than healthy weight children.</td>
<td>Mean additional baggage weight was 0.59kg for overweight children.</td>
</tr>
<tr>
<td>Healthy weight children tend to carry greater %BW than overweight children, but not to a significant level (p=0.070). Perhaps this is because they are required to carry the same amount of books as those with a higher BMI.</td>
<td>No overweight child perceived their bag as light.</td>
</tr>
<tr>
<td>No overweight child walked to school.</td>
<td>Medical attention was sought by significantly more overweight children than healthy weight children for MSKD in the last month (p=0.029).</td>
</tr>
</tbody>
</table>

Figure 9. Healthy Weight Children vs. Overweight Children.

A table showing the contrasting values and p-value calculations for healthy and overweight children can be seen in Appendix 8.

Note: Raw Data is available on accompanying CD.

### 7. Discussion

This study investigated the physical and psychosocial aspects of schoolbag carriage and some interesting findings can be deduced.

The majority (82%) carried above the recommended guideline of <10%BW. Carrying a heavier load appears to be the trend across Europe (Appendix 9). Perhaps a review of the guideline is necessary, if so many find it difficult to adhere to. This guideline was issued 36 years ago (Voll and Klimt 1977) and perhaps it is not realistic to meet the demands of today’s society. The American guideline for schoolbag weight is 10-15%BW. Notably in the current study, those who carried ~12%BW did not experience pain after
carriage, however those that carried ~15%BW did. There is scope here to further investigate the effects of increasing the recommended guideline.

If the guidelines are to be more rigidly adhered to, the child's ability to estimate schoolbag weight must also be addressed. Perhaps educational or manual handling sessions could be introduced in schools to first year schoolchildren, to increase awareness about loads on the musculoskeletal system. This may have a preventative effect on the development of MSKD, because the smaller first year post-primary schoolchildren are expected to carry equal load to older and larger children (Whittfield et al 2001). Another suggestion could be to decrease the load entirely with the introduction of iPads. This would decrease the weight expected to be carried by the child, but could also be a financially costly intervention.

All children in the current study carried their bags for a relatively short period of time. Only two children walked to school, while the rest were driven or took the bus or train. However, those who took the train would have had to walk some of their journey to school. The study does not capture the distance walked by those children, which is noted limitation of the study. Thus, the current study may not be representative of all the schools in Ireland and would limit the extrapolation of the findings. From the data it is evident that children carry their bags for longer periods of time on the way home from school. Perhaps children tend to loiter or 'hang out' after school, and carry their schoolbags for longer than necessary. The duration of carriage home from school is significantly related to reporting pain in the last month. This could signify a cumulative effect of carrying a schoolbag for longer than is necessary on the way home from school. These findings are in keeping with those of Grimmer and Williams (2006) and Young et al (2006) who found that longer durations of carriage are associated with higher pain prevalence. Duration of carriage is often a factor neglected in current literature.

Interestingly, shoulder pain was consistently the main area of pain reported at all three pain-recording intervals. This contrasts with current literature, which document that LBP is the most common symptom associated with schoolbag carriage. Pascoe et al (1997) found LBP (50.8%) to be the most common complaint, with shoulder pain at 14.7%. Also, males consistently reported a marginally higher intensity score than
females, which too contrasts with current literature. Perquin et al (2000) found that females were more likely to report multiple sites and higher intensities of pain (p<0.001). Notably, there was a lack of dissociation between gender and reporting pain. Previous studies have found that females tend to complain of pain more than males (Watson et al 2002; Skaggs et al 2006). In addition, physical activity appears to be a protective mechanism against pain. Those who played more sport complained less of pain. Wedderkopp et al (2009) report that high levels of physical activity protect against LBP in early adolescence.

An association was found between emotional wellbeing and LBP, which is in accordance with the literature. Van Gent et al (2003) found that psychosomatic factors had a strong relationship with neck, shoulder and back pain in adolescents. Unlike other studies, no relationship was found between pain reporting and family history of LBP. Balague et al (1995) reported that children were 2 fold more likely to report LBP if a there was a family history of LBP. Perhaps this finding is due to the small sample size.

This study has limitations that must be acknowledged. The majority (98%) played sport, as sports participation was compulsory in the school sampled. Thus, comparisons between schoolbag related MSKD of sedentary and active individuals could not be drawn. This was a non-blinded cross-sectional study, capturing only a moment in time. Schoolbag weights depend on the subject requirements and this varies daily. Children could have altered their schoolbag weight on data collection day, as they knew the study was being conducted. However, as ‘baseline’ discomfort needed to be assessed as part of the study design, it was impossible to conduct as a blinded trial. As this is a pilot study, there is scope to develop it in other post-primary schools across the country to attain a more generalized picture of the physical and psychosocial aspects of schoolbag related MSKD in Ireland.

8. Conclusion

Many children exceed the recommended <10%BW guideline. The majority was unable to correctly estimate bag weight, which is an essential skill if the guideline is to be adhered to. This is the first study to establish baseline MSKD and deeply assess the site and intensity of pain. Longer durations of carriage are associated with MSKD and the
shoulder complex was the main area of complaint. This deserves emphasis in future studies. Higher levels of physical activity were found to protect against MSKD. A unique feature of this study is the inclusion of psychosocial analysis, which found a link between emotional wellbeing and LBP. Psychosocial factors warrant further investigation in future research.
9. References


Strengths and Difficulties Questionnaire information:

Strengths and Difficulties Questionnaire Information:


Appendices
Appendix 1
Ethics approval omitted to prevent identification of the student.
Appendix 2a

Dear [Name],

Thank you for your interest in participating in our research, it is much appreciated. Included below is some more information regarding the study.

As part of our final year we are doing a research project on the weight of schoolbags that are carried by Irish schoolchildren and the effects that it can have on these children. We are also interested in the effects of children’s physical activity, bodyweight and emotional wellbeing on schoolbag carriage.

The project is aimed at all first year children in your school. Parental consent and child assent will be sought prior to the commencement of the study. Information leaflets, consent/assent forms will be sent home with the children. I am requesting your permission, and the co-operation of you and the relevant teachers to carry out this study in your school.

A copy of all information sheets, consent/assent forms and questionnaires are enclosed for your perusal. Confidentiality is ensured at all times. You are free to withdraw your school from the study at any time without further obligation.

If you require any further information please contact me, [Name]. Alternatively, our supervising lecturer [Name] can be contacted at [Phone] or [Email] or by e-mail at [Email]. We look forward to hearing from you and thank you for taking the time to read this letter.

Yours sincerely,

________________________

Jill Burns, Student Physiotherapist
Raymond Murray, Student Physiotherapist
Melissa Boland, Student Physiotherapist
Laura van Coppenhagen, Student Physiotherapist
Sara Dockrell MA, MEd, Dip. TP, MISCP, MIES, Project Supervisor
Introduction
Carrying a schoolbag is a common event for schoolchildren around the world. The weight of schoolbags, the method of carriage, the length of time that the schoolbag is carried, and the physical effects of schoolbag carriage have been the subject of investigation for some time. Schoolbag carriage has not yet been carefully investigated in the Republic of Ireland, although some small studies do exist. There is also a lack of research on the effects of a child’s bodyweight, physical activity and emotional well-being on the factors associated with schoolbag carriage.

Procedures
The study will take place in school, with your permission. Information leaflets, consent/assent forms will be delivered to you for distribution to the first year children in your school. Children who return the completed forms to the school for collection by the researchers will be included in the study. A brief session will be held with the children to verbally explain the study, to give them the opportunity to ask questions. The children will be shown how to complete a body discomfort chart (enclosed). They will be asked to complete:
- a Strengths and Difficulties Questionnaire at home (enclosed)
- the body discomfort chart just before they leave for school on the following morning
- another body discomfort chart on arrival to school, and

They will also be asked to fill out a questionnaire, with the help of the researchers, about:
- the type, method and length of schoolbag carriage to/from school
- usual amount of discomfort - schoolbag/non-schoolbag related
- frequency, duration and intensity of sporting activities and sedentary activities
- family history of Low Back Pain

The author-assisted questionnaire is enclosed.
Measurements will be taken of:
- schoolbag weight and any additional loads, such as sports gear and musical instruments
- children’s height and weight, in a measuring area with a minimum of two children and two researchers in the area at the time of measurement.

Benefits: Teachers, parents and children may be made more aware of schoolbag load and carriage. Any advice that is sought by anyone in connection with the project will be given.
Risks: There are no known risks associated with participation in this study.
Confidentiality: The identity of your school and the participating children will remain confidential.
Compensation: This study is covered by standard institutional indemnity insurance. Nothing in this document restricts or curtails your rights.
Voluntary Participation: If you decide to volunteer your school to participate in this study, you may withdraw at any time. If you decide not to participate, or if you withdraw, you will not be penalised and will not give up any benefits that you had before entering the study.
Stopping the study: You understand that the investigator may withdraw your school’s participation in the study at any time without your consent.
Permission: This research study has ethical approval from the School of Medicine Research Ethics Committee, Trinity College Dublin.
Further information: If you require any further information, I can be contacted at 086 3305053. Sara Dockrell can be contacted at 01 8962126, 0876653432 or by email sara.dockrell@tcd.ie.
Appendix 3a

Dear Parent/Guardian,

We are final year Physiotherapy Students in the Discipline of Physiotherapy, School of Medicine, Trinity College Dublin. As part of our final year research project, we are interested in the weight of schoolbags that are carried by Irish schoolchildren and the effects that it can have on the children. We are also interested in the effects of a child’s physical activity, bodyweight and emotional wellbeing on the pain or discomfort associated with schoolbag carriage.

Please find enclosed information leaflets and consent/assent forms for you and your child. Can you please complete your form and help your child to complete his/her assent form if needed? **Can you please give completed consent/assent forms to the school in the envelope provided by 5/3/2013. The forms are to be dropped into the box provided in the enquiries office.** Confidentiality is ensured at all times. There is no obligation for your child to participate and you are free to withdraw your child from the study at any time without further obligation.

If you have any questions about this research, you can contact me on [086 3305053](tel:086%203305053) or alternatively, contact our supervising lecturer [Sara Dockrell](mailto:sara.dockrell@tcd.ie) on [01 8962126](tel:01%208962126) or by email at [sara.dockrell@tcd.ie](mailto:sara.dockrell@tcd.ie). We look forward to hearing from you in the near future, and thank you for taking the time to read this letter.

Yours sincerely,

_______________________________

Jill Burns, Student Physiotherapist
Raymond Murray, Student Physiotherapist
Melissa Boland, Student Physiotherapist
Laura van Coppenhagen, Student Physiotherapist
Sara Dockrell MA, MEd, Dip. TP, MISCP, MIES, Project Supervisor
Appendix 3b

INFORMATION LEAFLET (PARENT/GUARDIAN)

A Study of Schoolbag Carriage among Irish Schoolchildren

Introduction
Carrying a schoolbag is a common event for schoolchildren around the world. The weight of schoolbags, the method of carriage, the length of time that the schoolbag is carried, and the discomfort associated with schoolbag carriage have been the subject of investigation for some time. Schoolbag carriage has not yet been carefully investigated in the Republic of Ireland, although some small studies do exist. There is also a lack of research on the effects of a child’s body weight, physical activity and emotional wellbeing on the pain or discomfort associated with schoolbag carriage.

Procedures
The study will take place in school with the permission of the Principal and teachers. A brief session will be held with the children to verbally explain the study and to give them the opportunity to ask questions. The children will be shown how to complete a body discomfort chart (enclosed).

The children will be asked:
- to complete the body discomfort chart just before they leave for school on the following morning,
- to give the completed chart to the researcher in the school,
- to complete another body discomfort chart on arrival to school
- to complete a Strengths and Difficulties Questionnaire (enclosed).

They will also be asked about:
- the type, method and duration of schoolbag carriage to/from school
- usual amount of discomfort - schoolbag/non-schoolbag related
- frequency, duration and intensity of sporting activities and sedentary activities
- family history of Low Back Pain, in a brief author-assisted questionnaire (enclosed).

Measurements will be taken of:
- schoolbag weight and any additional loads, such as sports gear and musical instruments.
- children’s height and weight in a measuring area with a minimum of two children and two researchers in the area at the time of measurement.

Benefits: You, your child or the teachers may be made more aware of schoolbag load. Any advice that is sought in connection with the project will be given to participants.

Risks: There are no known risks associated with participation in this study

Confidentiality: Confidentiality is assured at all times. Your child’s identity will remain confidential. Your child’s name will not be published and will not be disclosed to anyone outside the study. When signing the consent form your permission for possible publication of the results will be implied. Published material will not contain any information that identifies the school or any individual child.
**Compensation:** This study is covered by standard institutional indemnity insurance. Nothing in this document restricts or curtails your/your child's rights.

**Voluntary Participation:** If you decide to volunteer your child to participate in this study, he/she may withdraw at any time. If your child decides not to participate, or if your child withdraws, your child will not be penalised and will not give up any benefits that your child had before entering the study. Please keep a copy (enclosed) of the consent form.

**Stopping the study:** You understand that the investigator may withdraw your child's participation in the study at any time without your consent.

**Permission:**

**Further information:** If you require any further information, I (Jill Burns) can be contacted at 086 3305053 or alternatively our supervisor Sara Dockrell can be contacted at 0876653432 or 01 8962126 or by email sara.dockrell@tcd.ie.
Appendix 3c

INFORMATION LEAFLET (PUPIL PARTICIPANT)

A study of schoolbag weight

The project
Most students carry a schoolbag to and from school each day. We are interested to know more about the weight of schoolbags that are carried by Irish schoolchildren and any effects that they might have.

The project is about the measurement of you and your schoolbag.

- You will be asked to fill in a diagram just before you pick up your schoolbag and leave home and again when you get to school.
- You will be asked about:
  - your schoolbag
  - any usual amount of pain or discomfort
  - your hobbies
  - family history of Low Back Pain
  - your strengths and difficulties
- Your schoolbag will be weighed and your weight and height will be measured.

Consent
Before the study starts, you and your parent/guardian must agree that you can take part in the study. Neither you nor your school will be identified. You are free to pull out of the study at any time.

You will be given the opportunity to ask me any questions about the study.
Appendix 3d
INFORMED CONSENT FORM (PARENT/GUARDIAN)

A Study of Physical and Psychosocial Factors of Schoolbag Carriage among Irish Schoolchildren

DECLARATION:

I have read, or had read to me, the information leaflet for this project and I understand the contents. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to my child to be part of this research study, though without prejudice to his/her legal and ethical rights. I understand that I may withdraw my child from the study at any time and I have received a copy of this agreement.

PLEASE TICK AS APPROPRIATE

☐ I AGREE TO ALLOW MY CHILD TO PARTICIPATE IN THE STUDY

☐ I DO NOT AGREE TO ALLOW MY CHILD TO PARTICIPATE IN THE STUDY

PARTICIPANT'S NAME: .................................................................

NAME OF CONSENTER, PARENT or GUARDIAN : ............................................................

SIGNATURE:..............................................................................................................................

RELATION TO PARTICIPANT:..................................................................................................
Appendix 3e

INFORMED ASSENT FORM (CHILD PARTICIPANT)

NAME OF THE STUDY:

A study of schoolbag weight

I have been told about what is involved in this study and I have been given information in writing.
I know that my identity will only be known to the researcher.
I understand that I can pull out of the study at any time.

PLEASE TICK THE BOX OF THE ANSWER YOU WANT

☐ I AGREE TO BE IN THE STUDY

☐ I DO NOT AGREE TO BE IN THE STUDY

Your Name (BLOCK CAPITALS) __________________________

Your Signature ______________________________________

Date______________________________________________
Appendix 4 – Strengths and Difficulties Questionnaire (SDQ)

Strengths and Difficulties Questionnaire

For each item, please mark the box for Not True, Somewhat True or Certainly True. It would help us if you answered all items as best you can even if you are not absolutely certain or the item seems daft! Please give your answers on the basis of how things have been for you over the last six months.

Your Name........................................................................................................ Male/Female
Date of Birth.................................................................................................

<table>
<thead>
<tr>
<th>Item</th>
<th>Not True</th>
<th>Somewhat True</th>
<th>Certainly True</th>
</tr>
</thead>
<tbody>
<tr>
<td>I try to be nice to other people. I care about their feelings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am restless, I cannot stay still for long</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get a lot of headaches, stomach-aches or sickness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I usually share with others (food, games, pens etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get very angry and often lose my temper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am usually on my own. I generally play alone or keep to myself</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I usually do as I am told</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I worry a lot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am helpful if someone is hurt, upset or feeling ill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am constantly fidgeting or squirming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have one good friend or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I fight a lot. I can make other people do what I want</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am often unhappy, down-hearted or tearful</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other people my age generally like me</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am easily distracted, I find it difficult to concentrate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am nervous in new situations. I easily lose confidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am kind to younger children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am often accused of lying or cheating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other children or young people pick on me or bully me</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I often volunteer to help others (parents, teachers, children)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think before I do things</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I take things that are not mine from home, school or elsewhere</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get on better with adults than with people my own age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have many fears, I am easily scared</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I finish the work I'm doing. My attention is good</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your signature ............................................................................................

Today’s date ................................................................................................

Thank you very much for your help

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Appendix 5 – Body Discomfort Chart (BDC) and Visual Analogue Scale (VAS)

Body Discomfort Chart and Visual Analogue Scale (Pre)/(Post)/(One Month)

Do you have any soreness or pain now?

If you do, please draw the sore area on the body chart, and also put a mark on the line below to show how sore it is. If you have more than one area of soreness or pain, number the areas and put a mark on another line to show how sore it is.

Name ________________________

Front

Back

Sore Area Number:

________________________________________________________________________

Not sore                                             As sore as possible

Sore Area Number:

________________________________________________________________________

Not sore                                             As sore as possible

Sore Area Number:

________________________________________________________________________

Not sore                                             As sore as possible
Appendix 6 - Author-Assisted Questionnaire

An Investigation of Schoolbag Carriage among Irish Schoolchildren

Section 1 - About you

1. Child ID
2. School ID

3. Gender
   - Male
   - Female

4. Date of birth

5. The weight of my schoolbag is:
   - Heavy
   - Medium
   - Light

6. Weight (kg)
7. Height (cm)
8. BMI
9. BMIClass

Section 2 - About your schoolbag

10. Child+bag weight (Kg)
11. Child+bag+Additional weight (Kg)

12. Schoolbag weight (Kg)
13. Additional weight (Kg)

14. % weight bag only
15. % weight bag + Add weight

16. Schoolbag type:
   - Backpack
   - Shoulder bag
   - Handheld
   - Wheels
   - Other (please specify)

17. Method of carriage
   - Back: 2 shoulders
   - Back: 1 shoulder
   - Across body
   - One hand
   - Wheels
   - Other (please specify)

18. Duration of carriage (time(mins) of actual carriage, today)
   - <5
   - 5-10
   - 11-20
   - 21-30
   - >30

   To school
   From school (estimated)
Section 3. - About the things you do

19. Mode of travel **today**

<table>
<thead>
<tr>
<th></th>
<th>Walk</th>
<th>Cycle</th>
<th>Car</th>
<th>Bus/train</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>To school</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From school</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tick as many as appropriate
(Rank order if >1)

20. Do you exercise/play sport?  Yes [ ] No [ ]

If **yes**, how much time do you **usually** spend each **DAY** (hours)

<table>
<thead>
<tr>
<th></th>
<th>&lt;1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>&gt;5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21. Do you watch TV/videos or play computer or video games?  Yes [ ] No [ ]

If **yes**, how much time do you **usually** spend each **DAY** (hours)

<table>
<thead>
<tr>
<th></th>
<th>&lt;1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>&gt;5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section 4. – About you again!

22. Did you have any soreness or pain **that lasted for 1 day or more** in the **past month**?

   Yes [ ] No [ ]

If **Yes**, identify the area(s) on body chart and mark the level of **main soreness** on the line.
If **No**, please go to question 27.

23. How often were you sore/had pain?

   1 time/mth  2-3 times/mth  1 time/wk  2-3times/wk  every day

   [ ]  [ ]  [ ]  [ ]  [ ]
24. Did your soreness/pain interfere with: schoolwork? □ Yes □ No

sport? □ Yes □ No

hobbies? □ Yes □ No

sleep? □ Yes □ No

25. Did you get medical attention for the soreness/pain? Yes □ No □

26. Do you believe that any soreness or pain that lasted for 1 day or more, in the past month was due to/made worse by carrying your schoolbag?

Yes □ No □

27. Does anyone in your family have Back Pain?

Yes □ No □

THANK YOU FOR ANSWERING THESE QUESTIONS!
Appendix 7a – Body Mass Index: Male
Appendix 7b – Body Mass Index: Female
Appendix 8 – Characteristics for Healthy Weight vs. Overweight Children

Table 9. Values for Healthy Weight Children vs. Overweight Children.

<table>
<thead>
<tr>
<th></th>
<th>Healthy Weight (n=83)</th>
<th>Overweight (n=17)</th>
<th>Significance (p-value&lt;0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Months)</td>
<td>160.83 (± 0.37)</td>
<td>160.65 (± 1.63)</td>
<td>0.867</td>
</tr>
<tr>
<td>Weight (Kilograms)</td>
<td>50.29 (±0.74)</td>
<td>68.05 (±2.75)</td>
<td>0.0000*</td>
</tr>
<tr>
<td>Height (Centimetres)</td>
<td>161.60 (±0.76)</td>
<td>163.78 (±1.65)</td>
<td>0.242</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>19.15 (±0.19)</td>
<td>25.23 (±0.62)</td>
<td>0.0000*</td>
</tr>
<tr>
<td>SDQ Code</td>
<td>1.20 (±0.06)</td>
<td>1.41 (±0.17)</td>
<td>0.188</td>
</tr>
<tr>
<td>SDQ Total</td>
<td>9.25 (±0.50)</td>
<td>9.47 (±1.45)</td>
<td>0.866</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>72</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Borderline</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Abnormal</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Schoolbag Weight (kg)</td>
<td>7.20 (±0.24)</td>
<td>8.21 (±0.45)</td>
<td>0.079</td>
</tr>
<tr>
<td>Additional Baggage (kg)</td>
<td>0.73 (±0.15)</td>
<td>1.32 (±0.44)</td>
<td>0.120</td>
</tr>
<tr>
<td>%BW of Schoolbag</td>
<td>14.64 (±0.55)</td>
<td>12.32 (±0.78)</td>
<td>0.070</td>
</tr>
<tr>
<td>Perceived Load</td>
<td>21 - Heavy</td>
<td>5 – Heavy</td>
<td>0.280</td>
</tr>
<tr>
<td></td>
<td>42 - Medium</td>
<td>10 – Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 - Light</td>
<td>0 - Light</td>
<td></td>
</tr>
<tr>
<td>Correct Perception</td>
<td>40.5%</td>
<td>46.7%</td>
<td>0.661</td>
</tr>
<tr>
<td>Type of Schoolbag</td>
<td>76 – Backpack</td>
<td>17 – Backpack</td>
<td>0.214</td>
</tr>
<tr>
<td></td>
<td>7 - Shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of Carriage</td>
<td>80 – Shoulders x2</td>
<td>15 – Shoulder x2</td>
<td>0.624</td>
</tr>
<tr>
<td></td>
<td>3 – Shoulder x1</td>
<td>1 – Shoulder x1</td>
<td></td>
</tr>
<tr>
<td>Duration of Carriage to School</td>
<td>2 Children &gt;30min</td>
<td>All &lt;20min</td>
<td>0.367</td>
</tr>
<tr>
<td>Duration of Carriage from School</td>
<td>5 Children &gt; 30min</td>
<td>1 Child &gt;30min</td>
<td>0.862</td>
</tr>
<tr>
<td>Mode of Transport to School</td>
<td>2 Walk</td>
<td>0 Walk</td>
<td>0.801</td>
</tr>
<tr>
<td></td>
<td>Remainder = Car, Bus, Train</td>
<td>Remainder = Car, Bus, Train</td>
<td></td>
</tr>
<tr>
<td>Mode of Transport from School</td>
<td>2 Walk</td>
<td>1 Walk</td>
<td>0.651</td>
</tr>
<tr>
<td></td>
<td>Remainder = Car, Bus, Train</td>
<td>Remainder = Car, Bus, Train</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Hours</td>
<td>Days</td>
<td>Severity (VAS)</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>------</td>
<td>----------------</td>
</tr>
<tr>
<td>Sport;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Weekday hours</td>
<td>All</td>
<td>Up to 5+</td>
<td>≤ 3</td>
</tr>
<tr>
<td>- Weekend hours</td>
<td>All</td>
<td>Up to 5+</td>
<td>Up to 5+</td>
</tr>
<tr>
<td>TV/Video/Computer</td>
<td>All</td>
<td>Up to 5+</td>
<td>All</td>
</tr>
<tr>
<td>- Weekday hours</td>
<td>Up to 5+</td>
<td>Up to 5+</td>
<td>0.347</td>
</tr>
<tr>
<td>- Weekend hours</td>
<td>Up to 5+</td>
<td>Up to 5+</td>
<td>0.236</td>
</tr>
<tr>
<td>Discomfort before Carriage</td>
<td>52 – Yes (62.7%)</td>
<td>29 – No</td>
<td>3.53 (±0.35)</td>
</tr>
<tr>
<td>- Main Area</td>
<td>Shoulders, Back</td>
<td>14 – Yes (82.4%)</td>
<td>4.82 (±0.72)</td>
</tr>
<tr>
<td>- Severity (VAS)</td>
<td>3 – No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discomfort after Carriage</td>
<td>67 – Yes (80.7%)</td>
<td>15 – No</td>
<td>4.52 (±0.35)</td>
</tr>
<tr>
<td>- Main Area</td>
<td>Shoulder, Back</td>
<td>14 – Yes (82.4%)</td>
<td>0.070</td>
</tr>
<tr>
<td>- Severity (VAS)</td>
<td>3 – No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discomfort in Last Month</td>
<td>Yes: 61 (73.5%)</td>
<td>Yes: 12 (70.6%)</td>
<td>0.806</td>
</tr>
<tr>
<td>- Main Area</td>
<td>Shoulders, Back</td>
<td>Shoulders, Back</td>
<td>0.070</td>
</tr>
<tr>
<td>- Severity (VAS)</td>
<td>4.24 (±0.371)</td>
<td>5.00 (±0.91)</td>
<td>0.395</td>
</tr>
<tr>
<td>- Bag Related</td>
<td>Yes: 70.5%</td>
<td>Yes: 75%</td>
<td>0.650</td>
</tr>
<tr>
<td>- Medical Attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Interfered with;</td>
<td>Yes: 13.1%</td>
<td>Yes: 41.7%</td>
<td>0.029*</td>
</tr>
<tr>
<td>a) School</td>
<td>Yes: 12 (19.7%)</td>
<td>Yes: 2 (16.7%)</td>
<td>0.834</td>
</tr>
<tr>
<td>b) Sport</td>
<td>Yes: 39 (63.9%)</td>
<td>Yes: 10 (83.3%)</td>
<td>0.546</td>
</tr>
<tr>
<td>c) Hobbies</td>
<td>Yes: 18 (29.5%)</td>
<td>Yes: 5 (41.5%)</td>
<td>0.311</td>
</tr>
<tr>
<td>d) Sleep</td>
<td>Yes 12 (19.7%)</td>
<td>Yes 4 (33.3%)</td>
<td>0.479</td>
</tr>
<tr>
<td>History of Family Back Pain</td>
<td>Yes: 38 (45.8%)</td>
<td>Yes: 7 (33.3%)</td>
<td>0.479</td>
</tr>
</tbody>
</table>
Appendix 9 – Mean %BW Carried in the Literature by Children of Similar Age to those in the Current Study.

Figure 10. Mean %BW carried in the Literature.

- Goodgold et al (2002) – USA
- Negrini and Carabolona (2002) – Italy
- Van Gent et al (2003) – Austria
- Forjuoh et al (2003) – USA
- Kellis and Emmanouilidou (2010) – Greece