Kyphosis and Its Relationship with the Weight of Backpack and Bag of Female Students

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Abstract
Defining the factors affecting spinal disorders in female students and the direct effects of carrying heavy loads, their weight and type during school years is the main reasons behind conducting such studies. In order to do so, the paper attempts to investigate the relationship between Kyphosis disorder and the weight of schoolbags and backpacks in female primary and high school students. Statistical population of this study included all 10324 female students aged between 7 and 17 in Bonab. Using Morgan table, 370 students were selected through random cluster sampling and the rate of their Kyphosis was measured using the checkerboard. SPSS 21 computer application was used to do statistical calculations and the data were analyzed through independent T and Chi-square tests. The study revealed that weight and type of a bag could affect creation and development of Kyphosis disorder. Moreover, the rate of Kyphosis in primary school students was much higher in girls carrying backpacks compared to the ones carrying handbags. Yet, the study failed to find a significant relationship between Kyphosis disorder and weight and type of bags in high school students. It seems as if, choosing proper type and weight for the backpack along with the time a female primary school student carries it must be reconsidered, decent corrective exercises ought to be prescribed and the proper basis for their physical activities has to be provided.

Keywords: Corrective exercises; Female students; Kyphosis; Backpack; Schoolbag

Introduction
The level of individuals’ health in a society is an important index of development in countries. The future of a country greatly depends on dynamism and health in both mental and physical way of the adolescents and youth in that country so that healthy and strong individuals are the biggest national capital of a society (Xiangrong et al., 2014). Among all social institutions, school is one of the best officially organized institution which can flourish the kids and adolescent of a society by providing a healthy mental and physical context (Sankarson et al., 2014). All along school years the kid experiences physical, intellectual, emotional and social changes and if the environment is not ready for their perfection, various growth disorders and diseases may emerge (Emerson et al., 2014). Various models of bags available in the market encourage students to use different types without worrying about muscular and physical problems they may cause. Backpacks, front packs, double packs, front backpacks, low back packs, shoulder bags, hand bags and wheeled bags are only some of their types. Daily carrying of these bags impose heavy loads on spinal cords of young students and is the main reason for their disorders (Charles et al., 2014 & Daneshmandi et al., 2011). Several studies in different countries on bags, body posture change while carrying them and neglecting ergonomic principles in their design and their effect on children’s health. Some of these studies have concluded that improper carrying of bags, their heavy weight, bad form and size of them and the duration of their carriage are important reasons for lower back pains (Haselgrove et al., 2008). Backpacks are of special popularity among different groups of individual specially students of young ages.

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Nonstandard body posture in students while carrying heavy bags to school have raised concerns in parents, teachers and health authorities in the society and have made researchers interested in adverse effects of bad bags (Hussaini et al., 2009). Long-term effects of carrying bags on body are not yet discovered; however, loads imposed by these bags may have essential roles in skeletal-muscular disorders in students (Tarkeshwar et al., 2009). Two main disorders thought to be induced by carrying bad backpacks are kyphosis and scoliosis (AL-Khabaz and Shimada, 2008 & Gray et al., 2007). Researchers have found that carrying backpacks weighing over 10% of the body weight ends in kyphosis and lower pulmonary capacity in individuals (Mihailova et al., 2014 & Dorostimotlag et al., 2009). Studies have revealed that heart rate, blood pressure and energy used increased in 10 year old students carrying bags of weights over 10 and 20% of their body weight (Hong et al., 2008). Moreover, carrying backpacks weighing over 10% of body weight induces kyphosis and lower pulmonary activities (Mohammadi et al., 2012). Researchers have reported that weight and length of carrying backpack induces negative changes in students’ shoulders and necks (Cleiton et al., 2014 & Mohan et al., 2007). Skeletal disorders related to carrying bags are concurrent effects of factors like extra weight, size, form and length of carrying bags by students (Mihailova et al., 2014). Furthermore, they believe that the main reason for physical problems of sitting and walking or even awkward posture must be sought in bad habits of carrying heavy loads like bags full of books, bags hanging from one side of the body or carried by one hand (Cleiton et al., 2014). Besides, loads carried by students may risk their health and cause muscular pains, back pains, walking problems, deformed body parts and backaches (Mackie and Legg, 2008). Nowadays, backaches are among the most common complaints adults have all around the world and several reasons prove the relationship between backaches in kids and adolescents and backaches in adults (Sankarson et al., 2014). In case, a solution is offered for this long lasting costly problem of the kids and adults, it will become an everlasting attempt (Mohammadi et al., 2012). Researchers suggest backpacks maximum weight to be 10 or in some cases 20% of the body weight (Denise, 2008). However, the range proposed by majority of researchers is between 10 to 15% of the body weight (Devroey, 2007; Chow et al., 2010; Hussaini et al., 2009). Desired weight of backpack for primary school children must not exceed 7.5 to 8% of their body weight. Yet, there should be more investigations on the relationship between damages induced by backpacks and factors like their design, and personal factors like physical fitness along with compatibilities while carrying them. Anal investigated female students and observed strong connections between school bags, their carriage and backaches. Besides, the ratio of backpack weight and students’ body weight was significant. Nevertheless, Mostafazadeh did not report any significant relationship between bag and backpack weight with scoliosis and kyphosis disorders in his studies on primary school boys (Mostafazadeh, 2005). Most of the students in primary and high schools use backpacks to carry their staff most of which are heavy. Carrying these bags along with their weight and size and the students’ posture are drawing attention from parents, teachers and physicians (Daneshmandi et al., 2011 & Hussaini et al., 2012). Some studies have found that some 50% of students have bad habits of carrying things and bags (Daneshmandi et al., 2010). In a study on Iranian boys carrying backpacks, it was discovered that, younger students tend to imitate from their older counterparts and the weight of their bags are equal or sometimes heavier than that of older students carried bags (Zamanian et al., 2014). Therefore, considering the importance of investigations on the reasons behind disorders of back, backaches (Amal, 2012) and kyphosis in primary and high school girls while carrying bags and studying and the few studies conducted on the relationship between length of carrying bags, their weight and their type with spinal disorders in young female students, the present study will try to pioneer investigations on prevalence of kyphosis and the relationship between backpacks and this disorder. It will also try to give suggestions on correct methods of carrying bags and backpacks by young female students to avoid various disorders including kyphosis in the society.

**Methodology**

This descriptive field study is a quasi-experimental one, the hypotheses of which were evaluated through independent t and X2 tests. The statistical population of the study included all 10324 female students aged between 7 and 17 years (5954 primary school and 4370 high school students) studying in Bonab in the school year 2014-15. Statistical sample was selected through stratified cluster sampling put into different classes via randomly. These students were divided based on their family income and region of residence to far rural, near rural, suburb, downtown, well off families and low income families. Then with proper assignment from each class, samples were selected. Sampling from each class was conducted randomly and
according to the table of random sampling. Overall number of samples from each class had to be equal to the number of overall sample needed. Considering the size of the statistical population and according to Morgan table, statistical sample was decided to include 213 student of primary school and 157 students of high school making an overall of 370 subjects. Morgan table calculates the size of the statistical sample using the following equation:

\[ S = \frac{x^2 \cdot np(1-p)}{d^2(n-1) + x^2p(1-p)} \]

Where S is the size of the sample, N is the number of individuals in the society, d is the population ratio taken as 0.5 and P is the X2 value with one degree of freedom in confidence level of 0.95. Since some of the variables and collected data were of gradable nature, non-parametric X2 was used along with descriptive statistical methods and independent t test and the data acquired were analyzed using SPSS 21 computer application. In order to evaluate the condition of spinal cord, following devices were utilized. A checkerboard along with a vertical line with confidence level of 95% and reliability was used to measure kyphosis disorder in students (Rajabi, 2012). Digital scale with 0.1 kilogram precision capable of calibration (ws80 model, made in Switzerland) was utilized to record weight of the subjects and a height meter with minimum error of 0.1 cm with a broca plate (Machinen-AG, made in Switzerland) was used to measure their heights. Investigations on spinal cord was conducted using a checkerboard with a vertical line and several considerations were made not make any damage and observe cultural and ethical rules of each social class the subjects had come from in the posterior and lateral: Investigating the spinal cord from the posterior: the subjects stood beside a checkerboard wearing tight clothes and not wearing shoes and the vertical line hanging evaluated and examined the condition of shoulders (asymmetry of shoulders), deviation of spines (diagonal back), condition of the scapula (asymmetry of lower angels). In normal condition, vertical line was parallel with occipital bone, the seventh cervical vertebrae, along with shock frills and between two lobes of thigh. The vertical line on the lateral view had to be parallel with the middle of auricle, middle of shoulder, the big frill on thigh bone, on the side of patella, and front of the ankle (Letafatkar and Abdolvahabi, 2010). In the first stage, all the equipment needed were installed in the prayer hall and healthcare office of the school and then subjects were informed about different stages of the study along with physical disorders. Later on, their spinal cord condition was examined in front of the checker board with tight clothes on and finally, weight, size, and type of backpacks were measured without prior notice and the weight and height of the subjects were recorded as well.

**Results**

In order to evaluate the significance in the difference of backpack weight of primary school students in both healthy subjects and the ones suffering kyphosis, independent t test was applied. Results for the t test for both groups are represented in table 1.

<table>
<thead>
<tr>
<th>Disorder</th>
<th>average</th>
<th>Standard deviation</th>
<th>Levine test, Variance equality</th>
<th>t statistics</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disordered</td>
<td>2.671</td>
<td>0.56</td>
<td>F</td>
<td>5.61</td>
<td>0.000</td>
</tr>
<tr>
<td>Healthy</td>
<td>2.177</td>
<td>0.50</td>
<td>2.58</td>
<td>0.109</td>
<td>5.26</td>
</tr>
</tbody>
</table>

According to table 1, t test on comparing the backpack weight of primary school kids in both healthy and kyphosis groups revealed that there is a significant difference in the weight of backpack for both groups under study (P=0.000). Average weight of backpack for kids suffering kyphosis was 2.671 while average weight of backpack for healthy students was 2.177. The difference between bags of these two groups was 0.494 gram and statistically speaking this difference is significant (table 1).

In order to evaluate the significance in the difference of backpack weight of high school students in both healthy subjects and the ones suffering kyphosis, independent t test was applied. Results for the t test for both groups are represented in table 2.
Average weight of backpacks in subjects suffering kyphosis is 3.58 and for healthy students it is 3.525. The difference in the weight of bags is 0.055 gram and the difference is not statistically significant. According to table 2, t test for comparing backpack weight in high school students suffering kyphosis and the healthy ones it can be concluded that the relationship between backpack weight in healthy and kyphosis high school students is not significant (P=0.695). In order to test the significance of the relationship between carrying backpack by primary school girls and the possibility of kyphosis disorder, X² test was applied (table 3).

Considering the results from cross table on carrying backpack by primary school girls and the possibility of kyphosis, from among all 213 students under study, 170 subjects were healthy and 43 were suffering kyphosis. Three students were carrying hand bags all of whom were healthy. 66 students used one-sided backpacks 61 of whom were healthy and 5 were suffering kyphosis. 144 students were carrying backpacks 106 of whom were healthy and 38 were suffering kyphosis. According to the results from table 3, on X² test on the relationship between carrying backpacks by primary school students and the possibility of kyphosis disorder, it can be concluded that there is a significant relationship between carrying backpacks and possibility of kyphosis disorder in primary school girls (P=0.05).

In order to test the significance of the relationship between carrying backpack by high school girls and the possibility of kyphosis disorder, X² test was applied (table 4).
Considering the results from cross table on carrying backpack by primary school girls and the possibility of kyphosis, from among all 157 students under study, 107 subjects were healthy and 50 were suffering kyphosis. 44 students were carrying hand bags 29 of whom were healthy and 15 of them suffered kyphosis. 62 students used one-sided backpacks 47 of whom were healthy and 15 were suffering kyphosis. 51 students were carrying backpacks 31 of whom were healthy and 20 were suffering kyphosis. According to the results from table 4, on \( X^2 \) test on the relationship between carrying backpacks by primary school students and the possibility of kyphosis disorder, and considering the 0.217 level of significance, it can be concluded that there is no significant relationship between carrying backpacks and possibility of kyphosis disorder in high school girls (\( P=0.05 \)).

<table>
<thead>
<tr>
<th>variable</th>
<th>Primary school</th>
<th>High school</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of backpack to subject's weight</td>
<td>10 years &lt; 15 15 &gt; total</td>
<td>10 years &lt; 15 15 &gt; total</td>
</tr>
<tr>
<td>Frequency</td>
<td>161 40 12 213 153</td>
<td>4 0 157</td>
</tr>
<tr>
<td>Percentage</td>
<td>75.6 18.8 5.6 100 97.5 2.5 0 100</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>8.698 6.704</td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>3.318 1.741</td>
<td></td>
</tr>
<tr>
<td>variance</td>
<td>11.006 3.033</td>
<td></td>
</tr>
</tbody>
</table>

18.8% of students in primary schools and 2.5% of students in high school had the ratio of 10-15 for their backpack weight and the weight of their body. 5.6% of students in primary schools and 0% of students in high school had the ratio of over 15 for their backpack weight and the weight of their body. An overall 24.4% of the primary school students had a ratio of backpack weight and the weight of their body which is much higher compared to the 2.5% of high school students. Mean of the ratio between backpack weight and the weight of the body in primary school girls was 8.698 and this variable was 6.704 in high school students. Standard deviation of backpack weight to the weight of students in primary school girls was 3.318 whereas this number was 1.741 in high school girls.

Discussion

Findings of the present study revealed that there is a significant relationship between weight of the backpack and kyphosis disorder in primary school girls (table 1). This finding concord with findings of Mohammadi, Dorosti Motlagh et al., and Mackia and Leeg. They demonstrated that as the ratio of backpack weight exceeds 10% of student’s body weight, kyphosis possibility increases and pulmonary capacity decreases. They believed that carrying bags from primary school years imposes negative effects on skeletal muscular system of students of those schools and its continuance induce physical problems later in adulthood (Dorostimotlag et al., 2009 & Mohammadi et al., 2012). In the present study, 24.4% of students carried bags and backpacks weighing more than 10% of their body weight (table 5). Carrying these bags in primary school years has caused the hypothesis to be significant. Yet, this finding differs from findings of the studies conducted by Kathleen et al., Ramprasad et al., Zamanian et al., and Rajabi et al., They found that backpack weight has the greatest impact on shoulder pressures and since primary school children are in the age of growth, these problems are more serious. Carrying heavy backpacks in childhood causes bad physical condition in adulthood (Ramprasad et al., 2010). It seems as if weak skeleton of the subjects at early ages and not being able to carry heavy loads are the main features of this age (Cleiton et al., 2014). Body organs are still growing and are not strong enough at these ages; therefore, imposing heavy loads in the growth age will change and even block the epiphysis plate (Chow et al., 2010). Thus, ideal backpacks have two straps, air cushion and a belt to prevent damages to the shoulders (Mohammadi et al., 2012). Besides, results from this study revealed that the relationship between backpack weight and kyphosis disorder in high school girls is not significant (table 2). This finding does not concords with findings from studies by Xiangrong et al., Al-Khabaz & Shimada, Gray et al., Ramprasad et al., They revealed that heavy weight of the backpack drops the shoulders and bends the chest box or the back ending in hunch in the back. Yet, the
findings concord with results from studies conducted by Mihailova et al., Hussaini et al., Chow et al. and Mostafazadeh. Descriptive results from this study showed that only 2.5% of high school girls carry bags weighing more than 10% of their body weight (table 2). On the other hand, 67.5% of students in high school carried one-sided bags that did not have the effects of backpacks (table 4). It seems as if lower weight of the backpack along with correct carrying methods has caused the hypothesis of the study to be insignificant. Besides, modern technologies and transportation including car pool may have decreased the negative effects of backpack weight and ended in contradictory results from this study compared to previous ones (Hussaini et al., 2012 & Mihailova et al., 2014). Moreover, this study found that there is a significant relationship between type of carrying bags and kyphosis possibility in primary school girls (table 3). This findings concord with findings from studies by Norimitsu et al., Tarkeshwar & Michael, Dorosti Motlagh et al. Daneshmandi & Hussaini and Daneshmandi et al., They believe that backpacks weighing over 10% of body weight end in kyphosis (Daneshmandi et al., 2011 & Daneshmandi et al., 2010), negative impact on bone growth (Tarkeshwar et al., 2009) and lower pulmonary capacity of the individual (Ramprasad et al., 2010). However, this contradicts with findings from studies conducted by Charles et al., Olubayo-Fatiregun and Hussaini et al., They demonstrated that backpacks weighing over 10% of body weight do not have significant effects on skeletal condition heart rate, blood pressure, calorie usage and pulmonary ventilation (Charles et al., 2014 & Olubayo-Fatiregun, 2014). It seems as if the reason for this contradiction is the lower weight of backpacks and different lifestyles the subjects had. In this regard, 67.6% of subjects used backpacks (tables 3 & 4) and since at early ages the body tends to bend forward, upper limbs bend forward as well and as a result kyphosis emerges gradually (Daneshmandi et al., 2011 & Haselgrove et al., 2008). Results revealed that there is no significant relationship between type of carrying backpack and possibility of kyphosis disorder in high school girls (table 4). This finding contradicts with findings from studies by Dorosti Motlagh et al., Olubayo-Fatiregun et al., Al-Khbara and Shimada, Mohan et al., And Chow et al., They believe that carrying backpacks weighing more than 10% of the body weight ends in kyphosis (Norimitsu et al., 2014 & Chow et al., 2006). It seems as if using one-sided backpacks (67.5%) and lightweight backpacks compared to students’ body weight in high school (6.704) are the reasons for lack of relationship between carrying bags and kyphosis in high school students (table 4). Another important point at this age is that students try to keep up their appearances and therefore change their bags from hand to hand or shoulder to shoulder constantly and do a lot of physical exercises to keep up with their peers in their physical fitness (Dadban et al., 2013) and they hinder the process of kyphosis (Daneshmandi et al., 2010 and Rajabi et al., 2008). On the ratio of weight carried by students and their weights, did the study find that mean of this ratio in primary school and high school is 8.729 and 6.407 respectively (table 5). This finding concord with findings of Alaf et al., Amal et al. Daneshmandi & Hussaini, Hussainin et al., (2012 A & B). They demonstrated that primary school children carry heavier bags in relation to their body weight (Amal, 2012 & Alaf et al., 2014). Furthermore, the present study found that 24.4% of students carried bags weighing more than 10% more weight compared to their body weight (table 5). Nevertheless, researches by Hussaini et al., Revealed 9.5 and 11% to be the ideal and maximum extra weight compared to the body weight in primary school years. This finding concords with findings of Hussaini et al., (2012 A & B) and Daneshmandi et al., Who calculated the national norm for primary schools to be 9.5 to 11% or 2.10 to 3.90 kg and for high schools to be 7 to 8.5% or 4.25 to 5.60 kg. Unlike this study, Ramprasad et al., and Daneshmandi et al., Suggested maximum weight for primary school students to be 7.5 to 8% of the body weight (Daneshmandi et al., 2010 & Ramprasad et al. 2010). Accordingly, results from the present study show that primary school girls carry bags heavier than national standard weight for families normally tend to load them with food and refreshment in order not to use the cafe at school (Mohan et al., 2007). On the other hand parents and teachers may give general homework from whole books forcing students to carry all their books in their bags whereas high schools have lighter expectations of this kind from their students (Lafond et al., 2007). Findings from this study also demonstrate that average length of time primary school and high school girls carry are 8.79 and 5.36 minutes respectively. Whereas Daneshmandi et al. Reported that numbers to be 10.5, 14.5 and 19.45 for primary school, secondary school and high school students respectively. The reason for this significant difference in results from these studies may be using modern technologies like car-pooling (Salehazadeh et al., 2011) and other transportation facilities like family cars (Kathleen et al., 2014) along with social features and close distance of schools to homes (Mihailova et al., 2014).
Conclusion
Considering the results, a high percentage of girl students (20.2% primary school and 31.8% of high school girls) suffer kyphosis. On the other hand, heavy weight of the backpacks (Primary schools 8.896 kg and high schools 6.407 kg) and the length of carrying backpacks (8.79 minutes for primary schools and 5.36 minutes for high schools) along with weak physical fitness due to carpooling and family cars are among all social conditions worsening condition of kyphosis disorder in female students.

Suggestions
Holding workshops and offering courses on the reasons of disorders and necessity of physical fitness and improving methods for students, their parents and teachers on biomechanical principles, weight and organization of staff in the backpack are all of great importance. On the other hand mass media including TV, Radio, newspapers and other magazines and journals have to try to raise awareness on correct carrying habits and physical disorders.

References