Using “spinal shrinkage” as a trigger for motivating students to learn about obesity and adopt a healthy lifestyle

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Submitted 3 May 2008; accepted in final form 25 July 2008

Yar T. Using “spinal shrinkage” as a trigger for motivating students to learn about obesity and adopt a healthy lifestyle. Adv Physiol Educ 32: 237–241, 2008; doi:10.1152/advan.90141.2008.—Obesity is a global problem; however, relatively little attention is directed toward preparing and inspiring students of medicine and allied medical sciences to address this serious matter. Students are not routinely exposed to the assessment methods for obesity, its overall prevalence, causative factors, short- and long-term consequences, and its management by lifestyle modification. This physiology laboratory exercise involving students of medicine (n = 106) was developed to (1) introduce medical students to methods of obesity assessment and to differentiate between general and abdominal obesity, (2) generate an interest and sensitivity about obesity, and (3) stimulate thinking about modification of their lifestyle in relation to eating habits, weight control, and physical activity. Spinal shrinkage (the difference between the standing height of a person and his/her recumbent length) was used as an immediate observable parameter to demonstrate the effect of adiposity. Spinal shrinkage is recognized as an index of the compressive forces acting on the spine and is related to body mass index. A positive correlation (r = 0.365, P < 0.05) was observed between body mass index and spinal shrinkage. A questionnaire was used to assess student responses to this exercise. Students were motivated to engage in more physical activity (74%), adopt healthier eating (63%), and enhance their knowledge about obesity (67%). They expressed keen interest in the laboratory exercise and found the sessions enjoyable (91%). The laboratory exercise proved to be a success in motivating the students to actively learn and inquire about obesity and to adopt a healthier lifestyle.

Body mass index; obesity indexes; spinal loading

Over the past few decades, there has been both a decline in physical activity in children and adults and an increase in unhealthy eating. Overweightness and obesity have reached epidemic proportions among adults and children in the West and East (9, 22). Levels of overweightness and obesity are also rising in the Arab world, including Saudi Arabia (3). Obesity-related comorbidities, such as metabolic syndrome, and obesity-attributable medical expenditures are also on the increase (8). These demographic and economic trends suggest an urgent need to enthusiastically tackle the obesity epidemic from multiple fronts. One key avenue is creating awareness about obesity in students of medicine, nursing, and allied health professions.

Physicians, nurses, and other allied health professionals need to be motivated to engage themselves in routinely tracking body mass index (BMI), providing relevant guidance, and serving as role models in the community. This could be achieved by integrating learning of skills for the identification of overweightness and obesity in their curriculum at an early stage and by making them realize the gravity of situation on national and international levels. Prospective health professionals need to understand the widespread effects of obesity on individuals’ health and the enormous economic burden it imposes on country resources. Furthermore, it needs to be reinforced on a regular basis over the years by carving out an integrated set of exercises designed to gradually introduce the different facets of the problem of obesity and its management.

Students find properly planned and well-executed laboratory exercises not only interesting and appealing but also informative, challenging, and motivating (24). Such laboratory sessions tend to leave long-lasting effects on the minds of those involved.

The stature (height) of a person changes when one assumes an upright posture from a reclining position (12). This somewhat surprising result of an immediate observable change in the length of the person from the standing to lying down posture was used to capture the attention of students, and the relation of this spinal shrinkage with BMI was used as a motivator to bring about a positive change in attitude toward adopting a healthy lifestyle. The objective of this exercise was to (1) introduce medical students to methods of obesity assessment and to differentiate between general and abdominal (visceral, central) obesity, (2) generate interest and sensitivity about obesity, and (3) stimulate thinking about modification of their lifestyle in relation to eating habits, weight control, and physical activity.

Methods

Volunteers. During the year of 2006, second-year male medical students at King Faisal University (Dammam, Saudi Arabia) participated in a laboratory exercise aimed at creating greater awareness about obesity, its assessment, and its harmful effects on the body. These students had just finished their science courses in physics, chemistry, and biology and were fresh in physiology. The class of 106 students attending the Department of Physiology was divided into 4 groups, and, in the first 2 wk of the semester, each group of students dedicated 2 h/wk to this project; upon completion, students were assessed as to their interest in the laboratory exercise and its beneficial effects on their thinking regarding bringing about positive changes in their lifestyle.

Week 1. In the introductory session, the question was posed to students whether they expected any difference between the heights recorded while standing erect (standing height) and while lying down straight (supine height or recumbent length). As determined by asking them to raise their hands, 97 of 106 students either expressed ignorance or mentioned that there wouldn’t be any difference. Only nine students expressed the idea that the recumbent length would be longer because the effect of gravity on the body would be eliminated. The brief discussion that followed raised the possibility that if the individual was heavier, then the observed change in length would be greater.
To deal with the effect of variation in height between individuals, the concept of BMI was introduced at this juncture, and its importance and use as an index of adiposity/health were briefly discussed. Students were further motivated to suggest alternative measurements for assessing the level of obesity. They came up with measurements of waist circumference (WC) and hip circumference (HC). Similar to the concept of BMI, students were then introduced to the concept of the waist-to-hip ratio (WHR).

Students were then encouraged to prove or disprove the proposition of “spinal shrinkage” by adopting the approach of “check it out experimentally.”

Students were invited to demonstrate how to take height measurements with simple instruments, record weights, and measure WC and HC. After a discussion about the methods of taking the measurements, students were supplied with written instructions about the protocol (see the appendix for details). Four separate stations were established for actual measurements of 1) weight, 2) standing height (stature), 3) recumbent length (supine height or lying down height), and 4) WC and HC. Each student was provided with a data form for entering the personal details and records of their measurements. They were divided into groups of 3 students to take measurements, such that one student acted as a subject, a second student took the actual readings, and the third student recorded the data. Students in each group took turns to complete their data for all three members in their group and calculated their BMI, WHR, and spinal shrinkage (as shown in Table 1) and entered the values in their respective data forms. Students categorized themselves as underweight, normal weight, overweight, or obese on the basis of BMI (as shown in Table 2), which also provided the criteria for categorization according to other indexes of obesity. One of the teaching staff or technical staff was present at each of these stations to supervise the students and ensure quality control.

Analysis. After data had been acquired, each group representative entered their results into a computer-based, preformatted Excel file, which provided them with confirmation of their calculation of the individual values of BMI, WHR, absolute spinal shrinkage (in cm), and percent spinal shrinkage. The newly introduced concept of waist-to-height ratio was introduced at this stage (Tables 1 and 2). As the database was populated, the program displayed the cumulative results to give an idea of the trend in the particular group of students involved on that particular day of the experiment. At the end of this laboratory session, each student handed in the data form to the staff.

Week 2. The second session, in the following week, was used to present the cumulative data of the whole class. The results for BMI were selected for final display and discussion in relation to spinal shrinkage.

All the participating students were finally grouped as either underweight, normal weight, overweight, or obese on the basis of BMI.

The relationship of BMI with spinal shrinkage was calculated and presented in graphical format as shown in Fig. 1. Further statistical analysis was done using Pearson’s correlation tests between spinal shrinkage and BMI and presented as a scatter plot, as shown in Fig. 2.

The relevance of the whole experiment was discussed in the broader context of problems associated with obesity, the key issues of healthy diet and regular physical activity, and how to manage it on a personal level. The role of medical and allied health professionals in recognizing the problems of overweightness and obesity at an early stage and dealing with it with enthusiasm was highlighted.

Assessing learning issues. Finally, a questionnaire was distributed to all participating students to assess the usefulness of this exercise as a learning tool for the assessment of obesity and spinal shrinkage, understanding of the effect of BMI on the amount of shrinkage, the overall working environment, and the ability to generate enthusiasm to change their own lifestyle. Additionally, their interest in studying other phenomena in physiology in a similar fashion was also addressed. Students marked their responses on the questionnaire provided with a numerical scale of whole numbers from 0 (“no change”) to 5 (“very little”) to 10 (“a lot”). The survey was administered anonymously to the whole class of 106 second-year medical students attending the physiology course, of whom 90 responded.

RESULTS

Of a total of 106 medical students participating in the laboratory exercise, 13 students (12.3%) came under the category of obese, whereas another 30 students (28.3%) were classified as overweight. Thus, 43 students (40.6%) in that particular group were above the mark of BMI 25.

Figure 1 shows the definite trend of increasing spinal shrinkage with increasing BMI. An important observation was that only the obese group showed a significant difference from underweight and normal weight groups in the degree of shrinkage ($P < 0.01$) in this group of students. The results of the correlation test indicated a significant positive correlation ($P < 0.05$) between shrinkage and obesity (Fig. 2). The evidence from the presented results in the form of a rapidly observable effect of obesity on the spine was found to be quite convincing, conveying a clear message. Students were asked to come up with the consequences of excessive spinal loading, and, almost invariably, they related it with lower back pain.

The results of WC, WHR, and waist-to-height ratio along with BMI were used to briefly highlight the two patterns of obesity, i.e., general and abdominal obesity (7, 10, 11, 15).

Learning issues. The queries and student responses are shown in Table 3. Of the class of 106 students, 90 students responded by filling in the questionnaire. Students were motivated to engage in more physical activity (74%), adopt healthier eating (63%), and enhance their knowledge about obesity (67%), as shown in Table 3. They expressed keen interest in the laboratory exercise and found the sessions enjoyable (91%).

DISCUSSION

Spinal length and, consequently, body height changes are known to occur when one moves from a recumbent to an upright position (12) as well as over the course of the day (16) or with activity and rest (17). Investigators have observed a linear relationship in stature decrease and externally applied load on the spine (4) as well as a trend of greater spinal shrinkage in obese subjects compared with nonobese individuals subjected to an exercise task (19). The variation in the length of the spine is most probably related with the loading and unloading of the spine (6). The intervertebral disks respond to the application of axial loading by expelling fluid through their walls (1, 2), resulting in a decrease in the height of the disk. When a person lies down, the discs are unweighted, reversing this process. These changes in spine length can be

<table>
<thead>
<tr>
<th>Table 1. Calculations of obesity indexes, spinal shrinkage, and percent spinal shrinkage</th>
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<tbody>
<tr>
<td>BMI, kg/m²</td>
</tr>
<tr>
<td>WHR</td>
</tr>
<tr>
<td>Waist-to-height ratio</td>
</tr>
<tr>
<td>Spinal shrinkage, cm</td>
</tr>
<tr>
<td>Percent spinal shrinkage</td>
</tr>
</tbody>
</table>

BMI, body mass index; WHR, waist-to-hip ratio; WC, waist circumference.
quantified by measuring total body length (6, 18). The reduction in intervertebral disk height is associated with a decrease in the stability of the spinal motion segment and excess stress of other spinal structures that are not designed to withstand load and may be a source of pain. One of the problems linked to excessive weight in obese people is lower back pain (8), which is a common and serious public health problem (21).

The amount of shrinkage reported by various investigators varies depending on the experimental situation, protocol, and use of different sophisticated and precise measuring instruments. Our results, which were obtained with very simple instruments, were not very different from the results documented in these studies, although the magnitude of shrinkage varied somewhat.

Although the facts that spinal length shows circadian variation (16) and shortens when a person assumes upright posture from a reclining position (12) have been documented for many years, the number of individuals familiar with this idea appears to be relatively few. Thus, the initial question posed at the beginning of exercise, “whether there would be expected any difference between standing height and recumbent length,” generated interest and excitement in students, a key factor in motivating the students to learn (13). After capturing the attention of the students, their active participation was gained by inviting them to “check for themselves” by becoming both experimental subjects and investigators. Both physical and intellectual participation in a study that was of relevance and interest to them kept students engrossed in the exercise, and their working together in groups promoted cooperative learning (14, 24). It also motivated students to have more information about obesity (67%). Laboratory exercises where the relationship of serum leptin concentrations with BMI were explored have been successfully used to increase awareness about obesity (5).

Simple probing questions during the course of the exercise helped in generating an interactive learning environment, encouraged the students to think and come up with new ideas, and promoted meaningful learning (13). The exercise resulted in the development of a better understanding of the mechanisms underlying change in length of a person by changing the posture (85%), and students were able to correlate the degree of shrinkage to the level of obesity.

Another strength of the study was the immediate application of a concept. The students could immediately observe the deleterious effects of being overweight or obese. This quick demonstration of a deleterious effect of carrying an extra burden on the body as opposed to the somewhat hidden long-term cardiovascular or other effects related to obesity was appreciated by all. It proved to be a good motivator for students to attain and maintain healthy body composition and lifestyle by changing their eating habits (63%) and pursuing a more physically active life (74%). Whether the expressed intention (change in thinking) about the modification of lifestyle translated into a change in behavior of the participating students can only be judged by following up these students on a regular basis in later years of study. If the intending health professionals are motivated to act as role models and transfer the message to the public, it could help in scaling down the problem of obesity to some extent.

Not unexpectedly, the most difficult aspect was the motivation to change eating habits and pursuing a more rigorously active life style. About 37% of the students flatly stated their

<table>
<thead>
<tr>
<th>Category</th>
<th>BMI, kg/m²</th>
<th>WC, cm</th>
<th>WHR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5–24.9</td>
<td>94–101.9</td>
<td>80–87.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25–29.9</td>
<td>&gt;102</td>
<td>&gt;88</td>
</tr>
<tr>
<td>Obese</td>
<td>&gt;30</td>
<td></td>
<td></td>
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</tbody>
</table>

*From Refs. 7, 10, 11, and 23.

![Fig. 1. Spinal shrinkage in different groups based on body mass index (BMI). UW, underweight; NW, normal weight; OW, overweight; OB, obese. Numbers in parentheses indicate numbers of subjects in each category. Values are means ± SD; n = 106 subjects. *Significant difference between the two categories (P < 0.05).](image1)

![Fig. 2. Correlation of spinal shrinkage to BMI. r = 0.365, P < 0.05, n = 106 subjects.](image2)
disinterest in thinking about a change in eating behavior, and 26% of the students showed a similar attitude toward physical activity.

No single session or lecture is expected to change the behavior of an individual, but if two-thirds of the participants start thinking positively about these essential themes in the control of obesity, the whole exercise could be considered a significant achievement. Students developed a keen interest in the exercise as they got involved in it and as the cumulative results of the measurements were displayed. Students found the sessions enjoyable (91.1%) and were quite happy with the overall environment, an important aspect in promoting learning. They expressed increased enthusiasm for scientific inquiry, as indicated by their interest in similar exercises in other areas of physiology (89%).

Recommendations. The exercise presented is very simple and can be used to achieve diverse objectives, including the following:

- Inspiring students to become acquainted with various aspects of the global problem of obesity
- Learning methods of the assessment of obesity
- Fostering an inquisitive attitude toward physiology as an experimental science in which the answers to many questions are not known
- Encouraging a critical attitude toward results by asking students to present data as tables, graphs, etc. and then to interpret these results

As this exercise does not essentially involve sophisticated, expensive equipment, it can be performed in any situation where a basic setup and an enthusiastic coordinator are available. In places where precision stadiometers are available and facilities for impedance measurements can be acquired, extended formats of this laboratory exercise can be used.

In conclusion, this simple to perform laboratory exercise motivated students to actively engage in the measurement of their BMI and observe an immediate application of an important and relevant concept by looking at the relationship of BMI with spinal shrinkage. The exercise provided an opportunity for cooperative learning among students that was further reinforced by intermittent probing questions and discussions by the instructor during the course of two sessions. Finally, the students realized the importance of adopting a healthy lifestyle to combat a global problem of immense magnitude and widespread implications.

Table 3. Student assessment of the laboratory exercise

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean ± SD</th>
<th>Median</th>
<th>Range</th>
<th>Percent Showing a Positive Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I understand what is involved in spinal shrinkage.</td>
<td>7.66 ± 2.41</td>
<td>8</td>
<td>0–10</td>
<td>85.2</td>
</tr>
<tr>
<td>2. I am motivated to learn about obesity and its effects on the body.</td>
<td>6.87 ± 2.90</td>
<td>8</td>
<td>0–10</td>
<td>66.7</td>
</tr>
<tr>
<td>3. I am motivated to change my eating habits.</td>
<td>6.67 ± 3.10</td>
<td>7</td>
<td>0–10</td>
<td>62.9</td>
</tr>
<tr>
<td>4. I am motivated to follow a more physically active lifestyle.</td>
<td>7.19 ± 2.82</td>
<td>8</td>
<td>0–10</td>
<td>73.9</td>
</tr>
<tr>
<td>5. I am interested in studying other phenomena in physiology.</td>
<td>7.94 ± 2.02</td>
<td>9</td>
<td>0–10</td>
<td>88.9</td>
</tr>
<tr>
<td>6. I enjoyed the session.</td>
<td>8.23 ± 2.09</td>
<td>9</td>
<td>0–10</td>
<td>91.1</td>
</tr>
</tbody>
</table>

n = 90 student respondents.

Fig. 3. Illustration of the method for measuring recumbent length. A: construction of the wooden platforms. The large flat horizontal plate is wide enough in relation to the tabletop that one side firmly abuts against the wall while the other is level with the side having the measuring scale. B: the head-side wooden platform is clamped to the tabletop with G-clamps. The foot-side wooden platform is movable and can be slid along the wall against which the table is set. This ensures that the platform is perpendicular to the wall in addition to being perpendicular to the tabletop. The measuring scale is fixed to the side of the tabletop to facilitate the reading being taken.
APPENDIX: PROTOCOL FOR OBTAINING ANTHROPOMETRIC DATA

Weight

Weight was measured barefoot with light clothing (no shoes and no heavy clothing) in kilograms to the nearest 0.5 kg.

Height

Height was measured barefoot. Standing height always taken first, followed by the supine height (recumbent length), in centimeters to the nearest millimeter.

Standing height. Standing height was measured with heels close to the wall and feet close together so that weight was equally distributed, the head was straight, and the neck was neither flexed nor extended (Frankforts plane). Measurements were taken with a provided scale and set squares.

Recumbent length (supine height). Recumbent length was measured with a provided scale and vertical purpose-built right-angled wooden platforms (Fig. 3) while the subject was lying on top of a table. Each subject was asked to lie down on the table so that the head touched the fixed top platform and the feet touched the other adjustable platform in such a way that the soles of both feet firmly touched the platform (at the heels as well as at the metatarsophalangial area). The tips of the toes faced vertically up with the legs close together and the body lying straight (no curves). Measurement were taken after an arbitrary uniform settling down time of 2 min. The head-side wooden platform could be fixed to the top of the table with the help of G-clamps.

WC

Measurements were taken at a standing position at the level midway between the lower rib margin and the iliac crest and rounded to the nearest whole number or 0.5 cm. After subjects had removed any heavy outer garments and the contents of all pockets, a non-reflective tape was level (parallel to the floor) around the body, tightened but not so much as to depress the skin.

HC

Measurements were taken at a standing position (in cm) at the widest part of the hip bones over the buttocks and rounded to the nearest 0.5 cm. Similar precautions were taken as in the case of WC measurement.

ACKNOWLEDGMENTS

The author thanks Dr. Abdullah O. Bamosa (Chairman of the Physiology Department, King Faisal University) for allowing this study to be carried out. The author also thanks Dr. Basil Al-Shaikh for valuable suggestions in designing the questionnaire. In addition, the author is grateful to Dr. M. T. Al-Hariri, Nasim Jamil, Qaisar Humayun, and the participating medical students for the help in data acquisition, analysis, and presentation.

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