Author’s response to reviews

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Patterns of clustering of six health-compromising behaviours in Saudi adolescents

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Abstract

Background: Clustering of multiple health-compromising is usually associated with increased risk of cardiovascular diseases and cancers. There are few studies on patterns of clustering of multiple health-compromising behaviours in adolescents. Therefore, the aim of this study is to assess patterns of clustering of six health-compromising behaviours, namely, low fruit consumption, high sweet consumption, less frequent tooth brushing, low physical activity, physical fighting and smoking, among Saudi male adolescents.

Methods: A representative stratified cluster random sample of 1,335 Saudi Arabian male adolescents living in Riyadh city answered a questionnaire on health-related behaviours. Pairwise correlations were used for the six health-compromising behaviours and Hierarchical Agglomerative Cluster Analysis (HACA) for identifying clusters of the six health-compromising behaviours.

Results: The studied behaviours were correlated, but the coefficients were weak. HACA suggested two broad and stable clusters for the six health-compromising behaviours. The first cluster included low fruit consumption, less frequent tooth brushing and low physical activity. The second cluster included high sweets consumption, smoking and physical fighting.

Conclusions: The six health-compromising behaviours clustered into two conceptually distinct clusters among Saudi Arabian male adolescents, one reflecting non-adherence to preventive behaviours and the second, undertaking of risk behaviours.

Key Words

Health behaviours, clustering, patterns, male, adolescents
**Background**

Health-related behaviours cluster in a number of different patterns among adolescents and young adults. Raitakari et al. found that a poor diet, smoking, physical inactivity and excessive consumption of alcohol clustered in young adults [1], while Neumark-Sztainer et al. found associations between different health-compromising behaviours, namely, unhealthy weight loss, substance abuse, suicide risk, delinquency, and sexual activity [2]. In an extensive systematic review of studies published between 1995 and 2003 to identify the clustering of four health-related behaviours (smoking, alcohol abuse, safe sex and healthy nutrition) in adolescents (10-18 years) and assess their determinants Wiefferink et al. [3] identified three cluster patterns. The largest cluster was adolescents who ate healthily and who did not smoke or drink alcohol. The second cluster was adolescents who ate unhealthily and who smoked and drank alcohol. The third cluster was adolescents who ate unhealthily but did not smoke or drink alcohol. Later, Van Nieuwenhuijzen et al. [4] identified two clusters for younger adolescents aged 12-15 years, whereas there were three clusters for adolescents aged 16-18 years.

In summary, the few studies on the clustering of health-related behaviours among adolescents show that health-related behaviours cluster in different patterns. However, the number and types of health-related behaviours included in these studies differed, and they did not include a wide range of health-related behaviours. No studies examined patterns of clustering of a range of general health and oral
health-related behaviours among adolescents. Moreover, none used advanced
statistical methods such as the Hierarchical Agglomerative Cluster Analysis (HACA)
to assess clustering patterns. Therefore, a study was conducted to better understand
the clustering of multiple health-related behaviours among adolescents in a
developing country, using Hierarchical Agglomerative Cluster Analysis (HACA). The
aim of this study was to assess how six health-related behaviours, namely, low fruit
consumption, high sweet consumption, infrequent tooth brushing, low physical
activity, physical fighting and smoking cluster among male adolescents in Riyadh,
Saudi Arabia.

Methods

Subjects were Saudi males in two age groups: 13-14 year old students in 8th grade
intermediate schools and 17-19 year old students in 12th grade secondary schools.
These two age groups were considered to represent respectively the onset of
physical and emotional changes in early adolescence, and later adolescence when
young people are about to choose their future careers and have a greater degree of
autonomy [5]. For practical local reasons, females could not be included in the study
because all researchers were males, and men are not allowed to enter schools for
girls in Saudi Arabia.

The sample was selected by stratified cluster random sampling of schools. Schools
were first divided into four strata (public intermediate schools, public secondary
schools, private intermediate schools, and private secondary schools) and then
selected by simple random sampling in each stratum. All Grade 8 and 12 classes in the selected schools were recruited.

The sample size calculation was based on estimates of behavioural clustering from a pilot study and considered power of 80%, \( \alpha=0.05 \), a design factor of 1.2 to account for cluster sampling and 20% over-sampling for non-response. The calculated minimum final sample size was 980 students. For a representative sample of the relevant population in Riyadh, a self-weighting sample was used to select students from each stratum with the same proportion as in the general population [6]. That resulted in a sample size of 1100 students.

A self-administered classroom-based questionnaire used in the WHO cross-national study on Health Behaviour in School-Aged Children (HBSC) was adapted for use in this study [7]. The questionnaire included health-related behaviours, demographic characteristics, parent’s occupation and school environment. The questionnaire was developed in English and translated into Arabic by two qualified translators who were native speakers of Arabic and proficient in English. After that, the consensus Arabic questionnaire was backward translated into English and the backward translation was reviewed and compared for discrepancies with the original version [8]. No major differences were found. In addition, the Arabic questionnaire was reviewed by an expert teacher and then tested in a pilot study.
This study was approved by the University College London (UCL) Research Ethics Committee and the General Administration of Education at Riyadh Region, Saudi Arabia. Informed consent forms and information sheets were distributed through schools to parents and guardians. Positive parental written consent for all participants was received prior to the commencement of data collection. In conformity with procedures stipulated in the HBSC protocol [7], students were assured about anonymity and confidentiality of their responses. They were also given appropriate written and verbal instructions by the principal author (SA) at the beginning of the anonymised questionnaire.

Measures

Dietary behaviours included weekly frequency of eating fruit and sweets (never, less than once a week, once a week, 2-4 days a week, 5-6 days a week, once a day every day, more than once every day) [7]. Tooth brushing frequency was reported as "More than once a day, once a day, at least once a week but not daily, less than once a week, never" [9]. Physical activity was assessed through the 60 minute Moderate-to-Vigorous Physical Activity (MVPA) measure [10]. Physical fight frequency in the past year reported as “I have not been in a physical fight in the past 12 months” to “four times or more” [11]. Smoking was measured by “How often do you smoke tobacco at present?” Response options ranged from: “Every day” to “I do not smoke” [7].

Statistical analysis
The six health-related behaviours had different categorizations ranging from 4 to 7 categories. In order to make them directly comparable, they were dichotomized into binary variables (0 = healthy behaviour; and 1 = health-compromising behaviour) based on public health recommendations. Fruit consumption was dichotomized into once or more daily vs. less than once daily; sweet consumption into less than once daily vs. once or more daily; tooth brushing into twice or more daily vs. less than twice daily. For physical activity, an answer of 5 days or more per week indicates meeting physical activity recommendations, while less than 5 days per week indicates not meeting recommendations [10]. Physical fighting was categorised into none vs. one time or more in the last 12 months. Tobacco smoking was grouped into non-smoker and current smoker (at least once per week).

Pairwise correlations using Phi test for binary variables were used. Analysis of clustering was based on HACA. This is the most appropriate approach to identifying clusters of health-related behaviours [12]. It produces more stable cluster solutions compared to non-Hierarchical Cluster Analysis, and allows grouping of subjects that have similar characteristics across different variables leading to homogenous empirical types [12, 13]. HACA was therefore used to identify stable cluster solutions for the health-compromising behaviours, through an average linkage algorithm between groups that identified homogenous subgroups within the heterogeneous sample. We used Squared Euclidean distance as the measure of proximity, as it is suitable for binary variables [14]. The number of identifiable clusters was not known a priori. The Statistical Package for Social Sciences (SPSS for
Windows, version 16.0/PC; SPSS, Chicago, Illinois, USA) was used for statistical analysis.

Results

Of the 515 schools in Riyadh, 22 were randomly selected and agreed to participate in the study. We invited 1,354 eligible students to participate. There were no refusals by students or parents, but 19 questionnaires were excluded from the analysis because they were not fully completed. Therefore, the analytical sample was 1,335 students.

More than half the sample (54%) were 17-19 years old, and 52% of the adolescents attended public schools. About 85% of adolescents ate fruit less than once daily, 74% brushed their teeth less than twice daily, 64% had low physical activity, 51% had been involved in physical fighting at least once or more in the last 12 months, 43% ate sweets once or more daily and 23% smoked tobacco (Table 1). Low fruit consumption was positively correlated with low physical activity and less frequent tooth brushing (p<0.01). Smoking was positively correlated with physical fighting, low physical activity and high sweet consumption (p<0.01). The correlation coefficients were small, ranging from 0.08 to 0.12 (Table 2).

Figure 1 shows the hierarchical tree plot (dendrogram) which is a visual presentation of the distance (agglomeration schedules) at which clusters are combined. Pairs of variables with smaller distances were more similar and were
combined with average linkage in a group, while the variables with larger distances indicate the least homogenous groups [14]. Based on the proximity coefficients, low fruit consumption (E) and less frequent tooth brushing (T) were combined together in one group. After that, low physical activity (P) was also combined with E and T to form a cluster (Cluster 1). In the third stage, high sweet consumption (C) and smoking (S) formed a new group. In the fourth stage, physical fighting (F) combined with C and S to form a new cluster (Cluster 2). At stage four, there were two distinct clusters, with large distances (agglomeration coefficients) between them, thereby representing the best solution for this study population. These two distinct clusters with different patterns of health-compromising behaviours collectively included all six health-related behaviours.

The first cluster at the top of the dendrogram plot consisted of low fruit consumption, less frequent tooth brushing and low physical activity. The second cluster at the bottom of the dendrogram plot included high sweet consumption, smoking and physical fighting. The stability of the clusters was verified by repeating the HACA on different sub-samples drawn randomly from the study sample.

Discussion

Our HACA analysis identified two broad and stable clusters of health-compromising behaviours. The first cluster included low fruit consumption, less frequent tooth brushing and low physical activity, and the second cluster included high sweets consumption, smoking and physical fighting. These two clusters are quite distinct
conceptually, with the first reflecting non-adherence to preventive behaviours, while the second, to undertaking risk behaviours.

Previous studies reported associations between low fruit and vegetables consumption and low physical activity in adolescence [4, 15-18], and between tooth brushing and eating habits [19]. However, those studies only reported associations between two behaviours at a time, and did not look at clustering patterns of multiple health-related behaviours. Our findings go further in terms of identifying distinct clusters of multiple health-related behaviours. For example, we showed that less frequent tooth brushing clustered with low fruit consumption and low physical activity.

The second cluster (high sweets consumption, smoking and physical fighting) agrees partly with a systematic review that reported a significant association between high sweet consumption and smoking [20], while another study showed significant association between substance abuse and fighting [21]. The above-mentioned studies only reported associations between two behaviours. One potential explanation for our results showing a cluster of high sweet consumption, smoking and physical fighting is that these behaviours may have determinants in common [22]. For example, delinquency and rebellious behaviours might be important risk factors in adolescents, especially for clustering of smoking with physical fighting [4].
Previous research indicated that health-related behaviours were not independent of each other [23] and their interrelationships are multidimensional [24, 25]. Furthermore, the present study used statistical methods, not used heretofore, to assess clustering. The HACA used is a rigorous methodological tool that can be used to highlight the multidimensional relationships between health-related behaviours. It gives more stable cluster solutions compared to non-Hierarchical Cluster Analysis. Though it was used here in an exploratory manner, it has been used extensively in other research fields [12]. Our results confirmed that HACA is a valuable method to identify clustering of health-related behaviours.

This is the first study on the prevalence and clustering of multiple health-related behaviours among a representative sample of Saudi Arabian male adolescents. We used established data collection tools, adapted from the HBSC [7], and had a very high response rate. Moreover, a wide variety of important health-related behaviours among adolescents were included. However, this study has limitations. It was conducted only in Riyadh city, which might explain the relatively homogeneous study population. Also, for reasons beyond our control, girls were not included in this study. The data are self-reported, therefore might be subject to recall and social desirability bias. However, previous research showed that confidentiality and anonymity of self-reports reduces bias and provides reliable and valid data [26].

Our results have important implications for public health practice. Showing that there are two distinct and broad clusters of health-compromising behaviours
emphasizes the importance of a cluster-based approach in health promotion intervention planning and the potential greater impact of targeting multiple health-related behaviours [27, 28]. Oral health-related behaviours were clustered with general health-related behaviours. That emphasizes the importance of multidisciplinary health promotion interventions using the Common Risk Factor Approach [29]

Conclusions

The six health-compromising behaviours (low fruit consumption, high sweet consumption, less frequent tooth brushing, low physical activity, physical fighting and smoking) clustered into two clusters. One cluster contained health-compromising behaviours in terms of not conforming to preventive behaviours for fruit consumption, physical activity and tooth brushing. The other cluster consisted of risk-taking behaviours such as smoking, physical fighting and high sweets consumption. These two stable clusters appear to be representative clusters among Saudi Arabian male adolescents in Riyadh city.
List of abbreviations

HACA: Hierarchical Agglomerative Cluster Analysis
HBSC: Health Behaviour in School-Aged Children
MVPA: Moderate-to-Vigorous Physical Activity
E: low fruit consumption
T: less frequent tooth brushing
P: low physical activity
C: high sweet consumption
S: smoking
F: physical fighting

Competing interest

The authors declare that they have no competing interests.

Authors' contributions

SGA, RGW, AS and GT conceived the original research question. SGA undertook the data analysis with the support of MA and GT. All authors were involved in drafting and finalizing the paper.

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References


### Table 1: Characteristics of study sample

<table>
<thead>
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<th>%</th>
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<tr>
<td><strong>Age</strong></td>
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<td>13-14 years</td>
<td>613</td>
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<td>17-19 years</td>
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<td><strong>School type</strong></td>
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<td>Private</td>
<td>640</td>
<td>47.9</td>
</tr>
<tr>
<td>Public</td>
<td>695</td>
<td>52.1</td>
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<tr>
<td><strong>Health-compromising behaviours</strong></td>
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<tr>
<td>Low fruit consumption (Less than once daily)</td>
<td>1130</td>
<td>84.6</td>
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<tr>
<td>High sweet consumption (Once or more daily)</td>
<td>579</td>
<td>43.4</td>
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<tr>
<td>Less frequent toothbrushing (Less than twice daily)</td>
<td>991</td>
<td>74.2</td>
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<tr>
<td>Low physical activity (Less than 5 days per week of MVPA)</td>
<td>850</td>
<td>63.7</td>
</tr>
<tr>
<td>Physical fighting (One time or more per year)</td>
<td>677</td>
<td>50.7</td>
</tr>
<tr>
<td>Smoking (At least once or more per week)</td>
<td>312</td>
<td>23.4</td>
</tr>
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</table>

### Table 2: Pairwise correlations between health-compromising behaviours

<table>
<thead>
<tr>
<th></th>
<th>Low fruit consumption</th>
<th>High sweet consumption</th>
<th>Less frequent toothbrushing</th>
<th>Low physical activity</th>
<th>Physical Fighting</th>
<th>Smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low fruit consumption</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High sweet consumption</td>
<td>-0.03</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Less frequent toothbrushing</td>
<td>0.08**</td>
<td>0.03</td>
<td>1</td>
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<tr>
<td>Low physical activity</td>
<td>0.12**</td>
<td>-0.01</td>
<td>0.03</td>
<td>1</td>
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<td></td>
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<tr>
<td>Physical fighting</td>
<td>-0.002</td>
<td>0.02</td>
<td>-0.03</td>
<td>-0.03</td>
<td>1</td>
<td></td>
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<tr>
<td>Smoking</td>
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<td>0.08**</td>
<td>0.03</td>
<td>0.11**</td>
<td>0.08**</td>
<td>1</td>
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</table>

** Phi correlation was significant p<0.001