Nutritional knowledge among a large cohort of Italian students: a cross-sectional study

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Abstract. – **OBJECTIVE:** Healthy food behavior among adolescents represents a prevention factor for the onset of chronic diseases in adult life and is influenced by the familiar, socio-cultural and physical environment. Good nutritional knowledge plays a key role in ensuring healthy eating, that is adequate food choice and intake. This study aimed to assess the nutritional knowledge of Italian students from three Italian provinces of the Lazio Region (i.e., Rome, Frosinone, Latina) and to investigate its interrelationship with some socio-demographic characteristics (physical activity, parental education, school district city, BMI) of the surveyed subjects.

SUBJECTS AND METHODS: Students (n = 2573) were surveyed for their nutritional knowledge through the Italian version of the Moynihan questionnaire and for their socio-demographic characteristics. The relationship between their nutritional knowledge and their socio-demographic characteristics was investigated by univariate and multivariate statistical analyses.

RESULTS: Most participants displayed a normal weight (84%), followed by overweight (14%) and underweight (2%) subjects. Most students (44%) practiced physical activity at least twice a week. Most students (75%) reported a high family education level. Sixty percent of the subjects showed inadequate knowledge about healthy nutrition. A significant association ($p<0.001$) was observed between nutritional knowledge and school district city.

CONCLUSIONS: Educational nutrition programs should be promoted to improve nutritional knowledge among young people and reduce the risk of chronic disease development.

Key Words:
   Students, Adolescents, BMI, Moynihan questionnaire, Food choice, Nutrition, Nutritional knowledge.

Introduction

The prevalence of non-communicable diseases (NCDs) has increased over recent decades. Deaths due to NCDs amount to 41 million each year, accounting for 71% of global deaths[1]. Reduced physical activity, unhealthy food, and excessive caloric intake are risk factors for developing NCDs as well as obesity, diabetes mellitus, cancer, and cardiovascular and other inflammatory conditions[2].

Lifestyle factors affecting health status are gaining increasing interest in the research field, especially regarding adolescents and youth lifestyle practices[3,4]. Health-related behaviors are fundamental in preventing and controlling the onset of chronic illness and disability[4,5]. Healthy lifestyle practices, commonly, deal with diet, physical exercise, smoking, alcohol consumption and health screening. Among these factors, healthy nutrition and regular sport activity have a major positive influence on health as they prevent disease, increase longevity and ameliorate psychological wellbeing[6]. In adolescence, unhealthy behaviors like physical inactivity, smoking, and poor diet are recurrent and frequently interrelated. This is relevant because most health-related habits are established during adolescence and produce long-term health consequences in adulthood[7]. Proper eating habits and maintaining a healthy body weight are major prevention factors that significantly reduce the risk of illness and premature death from NCDs[8].

Poor nutritional knowledge and unhealthy eating habits are strictly related to abnormal body mass index (BMI), also among adolescents[9,10]. Overweight is associated with an increased risk

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for metabolic syndrome, hyperlipidemia, fatty liver, high blood pressure, type 2 diabetes mellitus, atherosclerotic cardiovascular disease, sleep apnea, osteoporosis[11]. Awareness about health risks related to underweight, instead, is usually less. Yet, underweight in adolescents was reported to be associated with scoliosis, osteoporosis, pubertal delay, and psychiatric disorders[10].

Insufficient or wrong awareness/knowledge about healthy nutrition causes many inappropriate food behaviors[12,13]. These may also be influenced by the physical environment surrounding children's and adolescents' home and schools[14,15]. The accessibility and availability of fast-food restaurants and convenience stores may negatively affect food choices[16] and young people from rural areas may be more at risk of obesity than those from urban areas, because of reduced sports activity and a more sedentary lifestyle[17].

NCDs in adulthood may be prevented by adopting appropriate nutritional habits and lifestyle at an earlier age. However, nutritional habits and characteristics of young healthy people are mostly unexplored in large cohort series.

Based on the above considerations, we performed a cross-sectional study among several school districts of the Lazio region (Central Italy), aiming at:

– Describing nutritional knowledge of students (13-20 years old)
– Correlating nutritional knowledge to socio-demographic characteristics (physical activity, parental education, school district city, BMI).

Subjects and Methods

Participants

This study enrolled 2785 high school Italian students, 13 to 20 years old, from ten high schools in the provinces of Rome, Latina and Frosinone, thus sampling different urban areas of the Lazio Region. 2704 out of the 2785 students participated to the survey, which took place from January to June 2015. One hundred and thirty-one of them returned incomplete data, so the final sample included 2573 students.

Study Design

The study protocol was approved by the Ethics Committee of the Catholic University of Rome (Prot. n. 27402/13 – 11/12/2013). Students who agreed to participate in the study provided their written informed consent if they were aged 18 years or above. The parents provided their consent for underaged participants.

Questionnaires regarding socio-demographic data, such as anthropometric characteristics, physical activity and parental education level, were administered to the enrolled subjects.

The participants were also asked to answer the Italian version of the questionnaire on nutritional knowledge by Moynihan[18]. The questionnaire was validated by the Italian Association for Cardiovascular Prevention, Rehabilitation and Epidemiology (IACPR) in collaboration with the Italian Association of Dietitians (ANDID). It consists of 15 questions (multiple choice and open answer ones), which focus mainly on a) the recommended consumption of fruit and vegetables, b) the knowledge about the different types of fats, c) omega-3s, d) fibers and the foods containing them and e) awareness of problems related to high consumption of fat, sugar and salt and low consumption of fruit and vegetables or fibers. Open questions relate only to this last point: subjects are asked about their awareness of any health problem related to the low or high intake of fibers, fruit and vegetables, fat, sugar or salt and to name (open question) related problems or health diseases. Wrong answers to multiple-choice questions score 2 points; right answers score 1 point. Open questions answers are scored 2 if wrong and 1 if right. The correct answers to the questionnaire and the score to be assigned were provided by ANDID. Thus, for each subject, it was possible to calculate an individual score on nutritional knowledge, ranging from 15 (best nutritional knowledge) to 30 (worst nutritional knowledge). The score was then categorized as "Low" (15-22), indicating better knowledge, or "High" (23-30), indicating worse knowledge.

Physical activity practiced by surveyed students was classified according to the frequency of exercise/sport participation, distinguishing no engagement in physical activity (0), a twice a week engagement (1) and a more than twice a week engagement, at a competitive level (2).

When surveyed, students were advised to consider extra school physical activity too.

To assess parental education, different education levels were identified: primary school education (0), middle school education (1) and high school or university degree (2). Each parent was assigned his/her education level, and the final parental education score (0-4) was obtained by summing the education level of both parents (Table I).

Table I. Categories identified for the different characteristics of the surveyed subjects.

Characteristic	Categories	Description
Nutritional knowledge	Low	Low Moynihan Questionnaire score – Better nutritional knowledge
	High	High Moynihan Questionnaire score – Worse nutritional knowledge
BMI [kg/m^2]	a	Thinness/Underweight
	b	Normal weight
	c	Overweight
Physical activity	0	No physical activity
	1	Physical activity twice a week
	2	Physical activity more than twice a week
Parental education	0	Both parents had primary school education
	1	At least one parent had middle school education
	2	At least one parent had graduated from high school or had university degree. Both parents had middle school education (1 + 1)
	3	One parent had graduated from high school or had university degree; one parent had middle school education (2 + 1)
	4	Both parents had graduated from high school or had university degree (2 + 2)
City	Rome	Students attending high school in Rome
	Frosinone	Students attending high school in Frosinone
	Latina	Students attending high school in Latina

Participants were characterized for their anthropometric characteristics (height/weight) by calculating their BMI, dividing their body weight in kilograms by the square of their height in meters (kg/m^2). The BMI is a well-known indicator of healthy/unhealthy weight in relation to height, being also widely considered as a risk factor for the development/prevalence of several pathologies.

Body Mass Index (BMI) data of subjects under 19 years were adjusted for age and sex using the BMI-for-age z-scores published by the World Health Organization[19]. The 20 years old subjects were categorized following the World Health Organization (WHO) categorization of BMI in adult people[20]. This allowed to group subjects into three BMI categories, namely a - b - c where "a" stands for thinness/underweight; "b" for normal weight and "c" for overweight.

The characteristics regarding nutritional knowledge, sports activity, parental education level, BMI, and school district city were classified into different categories, as summarized in Table I.

Statistical Analysis

To explore the associations between nutritional knowledge and each of the other subjects' characteristics (i.e., sex, BMI, physical activity, parental education level and school district city) univariate analyses were performed by carrying out Chi-square tests.

To investigate any relationship between nutritional knowledge and each of the other characteristics of the enrolled subjects (i.e., sex, physical activity, parental education level and school district city) multivariate logistic regression analyses were performed. The dependent variable was the nutritional knowledge. For independent variables, the reference categories were Female (F) for sex, no physical activity (0), both parents with primary school education (0) and Rome for city.

Data are expressed as mean ± standard deviation (SD) for continuous variables or percentages for categorical variables.

Results of all statistical analyses were considered significant if $p < 0.05$.

Results

Socio-Demographic Characteristics of the Subjects

Among the 2573 subjects enrolled in the study, 1526 (59.3%) were females and 1047 (40.7%) were males. Their socio-demographic data and anthropometric characteristics are shown in Table II.

Table II. Socio-demographic characteristics of subjects enrolled in the study (N = 2573).

Characteristic		Statistics
Sex, N (%)	Female	1526 (59.3)
	Male	1047 (40.7)
Age, mean (SD)		16.2 (1.5)
Weight [kg], mean (SD)		60.3 (10.9)
Height [cm], mean (SD)		169.9 (8.5)
BMI [kg/m^2], mean (SD)		20.79 (2.8)
BMI [kg/m^2], N (%)	a (Underweight)	51 (2)
	b (Normal weight)	2161 (84)
	c (Overweight)	361 (14)
Nutritional knowledge, N (%)	Low Moynihan score (Better nutritional knowledge)	1030 (40.0)
	High Moynihan score (Worse nutritional knowledge)	1543 (60.0)
Physical activity, N (%)	0 (No activity)	738 (28.7)
	1 (Twice a week)	1135 (44.1)
	2 (More than twice a week)	700 (27.2)
Parental education, N (%)	0 (Primary school for both parents)	7 (0.3)
	1 (Middle school for at least one parent)	15 (0.6)
	2 (Middle school for both parents or high school/ university for at least one parent)	199 (7.7)
	3 (High school/university for one parent; middle school for the other parent)	430 (16.7)
	4 (High school/university for both parents)	1922 (74.7)
City, N (%)	Rome	1058 (41.1)
	Frosinone	449 (17.5)
	Latina	1066 (41.4)

SD: standard deviation.

Participants were 13 to 20 years old (mean, 16.2 ±1.5). Mean weight and mean height were 60.3 ± 10.9 kg and 169.9 ± 8.5 cm, respectively.

Most participants featured a normal weight (N = 2161, 84%), while the overweight subjects (N = 361, 14%) were more than the underweight ones (N = 51, 2%). According to their Moynihan questionnaire score, most subjects (N = 1543, 60%) showed inadequate knowledge about healthy nutrition. Interestingly, enrolled students seemed to have a healthy lifestyle, practicing physical activity at least twice a week (N = 1135, 44.1%) or even at a competitive level (N = 700, 27.2%). Most subjects reported a high family education level, with both parents having a university degree or having graduated from high school (N = 1922, 74.7%). Finally, students attending high school in Rome and Latina were the most represented (N = 1058, 41.1% and N = 1066, 41.4%, respectively).

Relationship Between Nutritional Knowledge and All the Other Socio-Demographic Characteristics of the Subjects

Results of the univariate analysis investigating the association between nutritional knowledge of the subjects as assessed by the Moynihan questionnaire and the subjects' socio-demographic characteristics are shown in Table III.

A significant association was found between nutritional knowledge and school district city (Table III). The highest prevalence of subjects with adequate nutritional knowledge was observed in Latina (45.3%), followed by Frosinone (39.4%) and Rome (35%).

Conversely, no association was found among nutritional knowledge and sex, BMI, physical activity and parental education.

As a not statistically significant trend, most underweight and normal BMI subjects exhibited bad/incorrect nutritional knowledge, while almost no difference could be observed between low and high Moynihan questionnaire scores among overweight participants.

Results of the multivariate analysis showed a significant association between the subjects' nutritional knowledge and their school district city ($p<0.001$) (Table IV). In particular, the students attending high school in Latina had a 52% higher odd of displaying an inadequate knowledge on healthy nutrition than students attending high school in Rome.

Table III. Univariate analysis (Chi-Square test) for the association between nutritional knowledge and characteristics of the subjects.

Characteristic		Low Moynihan score N = 1030 (40.0)	High Moynihan score N = 1543 (60.0)	p-value
		Nutritional knowledge N (%)		
Sex	Female	621 (40.7)	905 (59.3)	
	Male	409 (39.1)	638 (60.9)	0.41
BMI [kg/m²]	a (Underweight)	18 (35.3)	33 (64.7)	
	b (Normal Weight)	856 (39.6)	1305 (60.4)	
	c (Overweight)	156 (43.2)	205 (56.8)	0.34
Physical activity	0 (No activity)	304 (41.2)	434 (58.8)	
	1 (Twice a week)	462 (40.7)	673 (59.3)	
	2 (More than twice a week)	264 (37.7)	436 (62.3)	0.33
Parental education	0 (Primary school for both parents)	2 (28.6)	5 (71.4)	
	1 (Middle school for at least one parent)	5 (33.3)	10 (66.7)	
	2 (Middle school for both parents or high school /university for at least one parent)	82 (41.2)	117 (58.8)	
	3 (High school/university for one parent; middle school for the other parent)	184 (42.8)	246 (57.2)	
	4 (High school/university for both parents)	757 (39.4)	1165 (60.6)	0.65
City	Rome	370 (35.0)	688 (65.0)	
	Frosinone	177 (39.4)	272 (60.6)	
	Latina	483 (45.3)	583 (54.7)	< 0.001

Discussion

The present cross-sectional study investigated the nutritional knowledge among a representative sample of 2573 students residing in three different provinces of the Lazio Region (i.e., Roma, Frosinone, Latina) and the relationship among their nutritional knowledge and different social/physical variables (i.e., physical activity, parental education, school district city, BMI).

Even if most students (2161, 84%) had a normal weight, almost one-third (738, 28.7%) stated to not perform any physical activity at all. Moreover, 60% of the surveyed subjects were observed to have a mostly insufficient/wrong nutritional knowledge.

The influence of nutritional knowledge on food behavior is well described in the recently published literature. Nutritional knowledge has been suggested to possibly play a role in the adoption

Table IV. Results of logistic regression investigating the association between nutritional knowledge and characteristics of the subjects.

Characteristic		Odds Ratio (95% CI)	p-value
Sex	Female	1	
	Male	0.94 (0.79-1.12)	0.50
Physical activity	0 (No activity)	1	
	1 (Twice a week)	1.03 (0.85-1.25)	0.76
	2 (More than twice a week)	0.90 (0.72-1.12)	0.36
Parental education	0 (Primary school for both parents)	1	
	1 (Middle school for at least one parent)	1.17 (0.16-8.41)	0.88
	2 (Middle school for both parents or high school/university for at least one parent)	1.80 (0.34-9.67)	0.49
	3 (High school/university for one parent; middle school for the other parent)	1.97 (0.37-10.39)	0.42
	4 (High school/university for both parents)	1.82 (0.35-9.55)	0.48
City	Rome	1	
	Frosinone	1.19 (0.95-1.50)	0.25
	Latina	1.52 (1.27-1.81)	< 0.0001

of healthier food habits[21-23]. Wardle et al[24] provided strong evidence for an association between nutritional knowledge and intake of fruit, vegetables and fat and demonstrated that good nutritional knowledge was significantly associated with healthy eating. These findings are consistent with those of another study on the influence of nutritional knowledge on fat consumption among students[25] showing students with greater nutritional knowledge consumed less unhealthy fats and cholesterol.

Poor nutritional knowledge can lead to inadequate food choice. Inadequate food intake, in turn, is well known to negatively affect the individual's health.

Food also influences the health state of individuals and whole communities. Industrialized countries have a widespread presence of metabolic and degenerative diseases for which food is an important risk or protective factor. Indeed, the scientific community agrees that diet plays a significant role in the pathogenesis of ischemic heart diseases, cerebrovascular diseases, diabetes mellitus, cancer, obesity.

The Mediterranean diet is an excellent example of a healthy, low-cost, accessible, and sustainable diet. It is characterized by a high intake of vegetables, fresh fruit, legumes, non-refined cereals, nuts, olive oil as well as by a moderate consumption of fish and dairy, and a low intake of red meat. Promoting a personalized diet therapy according to the Mediterranean model is fundamental to improve the health status of the population and reduce health costs while ensuring sustainability[26].

Nutritional knowledge of the enrolled subjects was also found to be significatively associated to school district cities featuring different sizes and urbanization levels (i.e., Rome, Latina and Frosinone).

These findings are in line with previous observational studies on the influence of urbanization on food behavior[27,28], as well as with quantitative investigations about differences in eating habits between countries, states, and cities[29]. Interestingly, a study on dietary choices of subjects living in cities of different size – from metropolises and big cities to medium and small towns – indicated that city size is predictive of food behavior[30].

A limitation of this study is represented by the fact that BMI does not consider the relationship between lean body mass and fat body mass. Thus, the overweight BMI could derive from an increase of lean body mass rather than fat mass, being in accordance with the adoption of health-related habits like regular engagement in physical activity. Other limitations concern not having considered nutritional habits of the students, alcohol consumption and smoking.

Conclusions

When young people move from adolescence to adulthood, they experience increased personal freedom and develop a different sense of identity. Over this period, they are at greater risk of engaging in inadequate food habits, including meal skipping and consuming unhealthy food. At that age, inadequate food habits – especially when associated with reduced physical activity – increase their odds of developing, later in life, severe disorders including osteoporosis, obesity, hyperlipidemia, diabetes, and cancer. Developing healthy eating habits at an early age is, therefore, of paramount importance. For this, educational programs involving young people should specifically aim at increasing their nutritional knowledge.

The development of educational strategies aimed at improving specific knowledge of food composition, functions, use and association, appears to be an important prerequisite for the promotion of health-related behaviors, also among youths. Giving adolescents better skills to recognize a healthy diet style would empower them to have more control over their food choices. To this end, not only the family but also the school environment may play a role in determining health awareness of youths.

Ultimately, this study could provide new insights for implementing effective intervention programs that support healthy eating and behavior among students.

Authors' Contribution
M.C. Mentella, V. Mora, G. Addolorato, and A. Gasbarrini: conceptualization; M.C. Mentella, V. Mora, G. Addolorato:

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