

# Methods and introductory results of the Greek national health and nutrition survey - HYDRIA

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## ABSTRACT

**Background:** According to a large prospective cohort study (with baseline examination in the 1990s) and smaller studies that followed, the population in Greece has been gradually deprived of the favorable morbidity and mortality indices recorded in the 1960s. The HYDRIA survey conducted in 2013-14 is the first nationally representative survey, which collected data related to the health and nutrition of the population in Greece.

**Methods:** The survey sample consists of 4011 males (47%) and females aged 18 years and over. Data collection included interviewer-administered questionnaires on personal characteristics, lifestyle choices, dietary habits and medical history; measurements of somatometry and blood pressure; and, blood drawing. Weighting factors were applied to ensure national representativeness of results.

**Results:** Three out of five adults in Greece reported suffering of a chronic disease, with diabetes mellitus and chronic depression being the more frequent ones among older individuals. The population is also experiencing an overweight/obesity epidemic, since seven out of 10 adults are either overweight or obese. In addition, 40% of the population bears indications of hypertension. Smoking is still common and among women the prevalence was higher in younger age groups. Social disparities were observed in the prevalence of chronic diseases and mortality risk factors (hypertension, obesity, impaired lipid profile and high blood glucose levels).

**Conclusion:** Excess body weight, hypertension, the smoking habit and the population's limited physical activity are the predominant challenges that public health officials have to deal with in formulating policies and designing actions for the population in Greece.

*Key words:* Greece, HYDRIA, diet, health, national

## INTRODUCTION

In the decades after the Second World War, the population in Greece was experiencing favorable health indices in spite of the difficult post-war conditions. In the

1960s and while the financial capacity of the country was limited, Greeks had a high life expectancy and mortality from coronary heart disease or cancer (particularly cancers of the colon, prostate and female breast) was one of the lowest in Europe [1]. In the last decades of the 20<sup>th</sup> century

and particularly in the 1990s, Greeks experienced high rates of development which were reflected in their income and living conditions, but were also accompanied by shifts of the population towards unfavorable dietary and other lifestyle choices. Based on the observations made in the baseline examination of a large prospective cohort study (the Greek European Prospective Investigation into Cancer and nutrition – the EPIC study) which recruited about 30,000 individuals from regions all over the country, in late 1990s the comparative advantage of Greeks towards other Europeans was gradually disappearing, because of: (a) the smoking epidemic - about 75% of adult males and about 28% of females were current or former smokers; (b) the high prevalence of overweight and obesity - more than 50% of males and more than 33% of females aged 35 years and over were overweight or obese; (c) the loss of regular physical activity as part of the daily life; (d) the inefficient control of hypertension and diabetes, the latter with a self-reported prevalence of more than 10% in some age groups and (e) the abandoning of the traditional Mediterranean dietary habits [2,3].

In the years that followed, several studies of smaller scale and regional nature provided additional evidence. According to the baseline examination of a prospective study recruiting in 2001 – 2002 in the Attica region, 3042 adults (mean age 45 years; 50% males), 53% of participants were overweight or obese, 45% were smokers, 43% hypercholesterolemic, 31% hypertensives, 7% reported a history of diabetes mellitus and 68% reported a sedentary lifestyle or low physical activity [4,5]. In a cross-sectional study conducted in 2001-2003 among approximately 1500 adults from all the communities in the municipality of Tripoli (Central Peloponnesus, Greece), 62% of study participants were overweight or obese, 21% were current smokers and 87% reported that they did not follow any physical activity on a regular basis [6]. A study among 502 male and female farmers conducted in 2005 in Crete confirmed the high prevalence of obesity and central adiposity, as 43% of study participants were obese, while 40% of men and 86% of women suffered from central obesity, in particular [7]. In the cohort of the international MEDIS study, 669 Greek residents of islands in the Aegean Sea (mean age 74 years, 43% males) were recruited between 2005 and 2015. In their baseline examination, 67% reported a history of hypertension, 25% of diabetes mellitus, 56% of hypercholesterolemia and 43% were obese [8]. In addition, several publications provided evidence that Greeks – and the younger ones in particular – were gradually abandoning their traditional eating habits [9].

In light of the alarming evidence, the Hellenic Ministry of Health supported the first national health and nutrition survey in Greece (the HYDRIA survey). The study was coordinated by the Hellenic Health Foundation (HHF), in collaboration with the Hellenic Centre for Disease Control and Prevention. The present manuscript provides an overview of the survey's methods and procedures together

with some preliminary results on the prevalence of risk factors and disease conditions recorded in 2013-14 in a nationally representative sample of adults, permanent residents of Greece.

## METHODS

### The HYDRIA survey sample

The target population was males and females aged 18 years and over, who permanently reside in Greece based on the most recent general census of 2011. The corresponding sampling frame covered all the 51 prefectures of the 13 regions of the country. A two-stage stratified random sampling was applied with the primary sampling unit being the municipality/local community (1<sup>st</sup> stage) and the final unit being the individual (2<sup>nd</sup> stage). The surveyed units were initially divided into homogeneous sub-populations (strata) according to the geographic division of the country and the degree of urbanisation of the permanent residential area (urban, semi-urban, rural).

About 8,000 individuals were invited to participate and 4,011 (1,873 males and 2,138 females) finally agreed to take part in the study (50% response rate). Table 1 provides the distribution of the HYDRIA survey sample by age group, educational level and employment category, in relation to the population in Greece overall and separately by gender. The age and gender distribution of the HYDRIA survey sample did not deviate substantially from that of the population in Greece. It consists of 47% males and 53% females (48% and 52% of the population in Greece were males and females, according to the 2011 census). The largest deviation (about 5%) from the country's population was observed in persons aged 75 years and over and among women in particular, reflecting probably the difficulty older people encounter in participating in this type of research. In comparison to the population of Greece, the HYDRIA survey sample included fewer participants of low and more participants of high educational attainment. However, taking into consideration that older people usually followed lower levels of education, the distribution of the sample by educational level probably provides additional evidence of a smaller response rate among older individuals. The distribution of the survey sample by employment status resembled that of the country's population, with the exception of male pensioners (larger percentage in the sample than in the country) and housewives (smaller percentage in the sample than in the country).

In order to address deviations of the study sample from the target population, weighting factors were estimated and applied to allow for nationally representative results. Weighting factors were calculated on the basis of the 2011 Greek census taking into consideration the sampling design and the response rate by geographical region, degree of urbanisation, gender and age group. Weighting

**TABLE 1. Distribution (%) of the 4011 participants relative to the population in Greece<sup>a</sup>, by age group, educational level and employment status and separately by gender. The HYDRIA survey.**

	MALES		FEMALES		TOTAL	
	HYDRIA	GREECE	HYDRIA	GREECE	HYDRIA	GREECE
<b>Age (years)</b>						
18-24	7.9	8.7	9.2	8.2	8.6	8.5
25-34	16.4	16.7	15.5	15.0	15.9	15.8
35-44	19.0	19.1	19.3	17.6	19.2	18.4
45-54	18.2	17.6	19.1	17.3	18.7	17.4
55-64	16.8	14.8	17.0	15.0	16.9	14.9
65-74	13.2	11.9	12.2	12.6	12.7	12.2
≥75	8.5	11.3	7.7	14.3	8.1	12.8
<b>Educational level</b>						
Low	25.4	34.6	30.2	43.7	28.0	39.3
Medium	41.0	41.8	42.0	36.3	41.5	38.9
High	33.6	23.6	27.8	20.1	30.5	21.8
<b>Employment status</b>						
Employed	50.5	51.8	33.4	31.8	41.4	41.4
Unemployed	13.4	14.5	16.7	14.6	15.1	14.6
Students	4.5	5.5	5.0	5.0	4.8	5.2
Pensioners	31.7	28.1	23.0	22.1	27.1	25.0
House-keepers	0.1	0.0	21.9	26.5	11.7	13.8

<sup>a</sup> Source: Hellenic Statistical Authority (ELSTAT) [26].

factors were subsequently calibrated to increase the accuracy of results, based on auxiliary information about population totals and marginal counts regarding age, gender, education and employment status (using the CALMAR SAS macro) [10].

### The pilot study

The HYDRIA survey is the first national study on health and nutrition of the adult population in Greece. The methodology applied has been developed in accordance to international standards for collecting health-related data and associated risk factors at national level [11] and for the undertaking of dietary surveys [12]. Prior to their broad application, the HYDRIA methods and procedures were pilot-tested through two preliminary studies: (a) the European Health Examination Survey (EHES)-Pilot Joint Action 2009-2011, coordinated by the National Institute of Health and Welfare in Finland and funded by the European Commission Directorate General for Health and Food Safety and (b) the PILOT-PANEU project coordinated by the Hungarian Food Safety Authority and supported by the European Food Safety Authority. Observations made through the two pilot studies were used to improve the methods and related data collection tools. Upon completion of the pilot studies, a

three-day practical training was organized to familiarize and train the fieldwork teams and 55 health professionals from all regions of the country on the procedures followed to ensure standardization and to minimize deviations from the study protocol.

### Data collection

The data collection included interviewer-administered questionnaires, measurements of blood pressure, heart rate and somatometric characteristics, and blood drawing. Survey sites mainly included local health centers. Public (town hall, peripheral doctors' office) and teaching premises (colleges, libraries, gymnastic halls), open care community centres for the elderly and community clinics were also used. Moreover, a mobile unit with facilities to perform somatometric measurements, personal interviews, blood drawing and processing was also available to enhance the participation of eligible individuals who were unable to reach the study centre. The data collection started in June 2013, was completed in December 2014 and included the following procedures:

- a. *Consent to participate.* In accordance to the Helsinki declaration and national legislation on the protection of individual data, each eligible

- individual received detailed information about the scope and procedures of the HYDRIA survey and provided a signed consent to participate.
- b. *Administration of questionnaires*, facilitated by trained interviewers. Participants were asked to provide information on their personal characteristics (date of birth, residential area, educational attainment, occupation status and employment), lifestyle choices (smoking and physical activity) as well as their medical history. Furthermore, participants were asked to describe the frequency of consuming foods and dietary supplements in the previous year through a non-quantitative food frequency questionnaire and to outline their eating out choices during the previous month through a specially designed questionnaire on attitudes towards eating out. Lastly, participants provided a detailed 24-hour dietary recall through a specially designed software application, the HHF Nutrition Tool.
  - c. *Somatometric assessment*, which included measurements of standing height, body weight, waist and hip circumference. Height was measured using a portable stadiometer to the nearest 0.1 cm, body weight was assessed using Tanita scales (model TBF-300GS, SC-330, 300P) to the nearest 0.1 g and circumferences were measured using an elastic tape to the nearest 0.1 cm. Before the assessment, participants were asked to remove shoes, heavy clothing, hair ornaments and head dress. Measurements were performed in accordance to standardized procedures for the calibration and application of measuring devices set by the EHES Coordinating Centre in Finland. Any deviation from the protocol, as well as reasons for not measuring the participant's somatometric characteristics were recorded in a special form.
  - d. *Measurement of blood pressure*, performed by trained health professionals using a mercury sphygmomanometer (model Riester Diplomat and Littmann select). Participants were advised to abstain from any dietary intake and smoking for at least one hour before visiting the study center and were asked to empty their bladder before measurements were undertaken. Participants were seated in a chair, with their backs supported and their right arm bared at the level of the heart. The arm's circumference was measured and the appropriate cuff was selected - four cuffs with circumferences ranging from 11 to 48 cm were available at site. After five minutes of rest, heart rates, systolic and diastolic blood pressure were measured three times, with at least a two minutes' interval between measurements. The averages of the three readings for both systolic and diastolic

blood pressure were used. Deviations from the protocol were recorded in a special form.

- e. *Blood drawing*. A blood sample of approximately 20 mL was collected with participants in a sitting position preceded by a 10-15 min rest. Prior to their visit to the study center, participants were asked to avoid heavy physical activity or training for at least eight hours. Information about the length of time since the last physical activity, together with information on the participant's current medication was documented in a special form. All blood samples were collected, centrifuged, aliquoted and temporarily stored at -20°C on site. They were subsequently placed in styrofoam boxes and transported in dry ice to the survey coordinating center for further analysis or storage at deep freeze (-80°C). Any protocol deviations were again recorded.

### Statistical analysis

Differences in mean values of continuous variables were assessed through t-tests. Differences in proportion distributions of qualitative characteristics by gender, age-groups or categories of educational attainment were assessed through chi-square tests. Education, employment status and somatometry were reflected by categorical variables. Educational attainment was grouped in three categories: (a) *low*, including illiterate individuals and those who had up to nine years of education/training (b) *intermediate*, with individuals who followed school (including any type of vocational training) for more than nine and up to twelve years and (c) *high*, including university graduates, postgraduate and/or doctoral degree holders. Employment status was grouped in five categories: (a) *employed individuals*, including unpaid helpers in family businesses, paid apprentices, investors and persons temporarily absent from work due to sick leave, holiday leave, maternity or parental leave (b) *unemployed*, (c) *students*, including postgraduates and interns working without pay for experience (d) *pensioners* and (e) *housekeepers*. The Body Mass Index (BMI) was calculated through body weight (in kilograms) divided by the square of height (in meters). Based on their BMI values, participants were grouped in four categories: (a) *underweight* (<18.5 kg/m<sup>2</sup>), (b) *normal weight* (18.5-24.9 kg/m<sup>2</sup>), (c) *overweight* (25-29.9 kg/m<sup>2</sup>) and (d) *obese* (≥30 kg/m<sup>2</sup>). A validated questionnaire [13, 14] was used to record usual physical activity and daily energy expenditure was calculated in metabolic equivalents (Metabolic Equivalents of Tasks, METs). The METs express the ratio of the energy cost of a particular activity to the individual's resting metabolic rate and reflect the intensity of physical activities [15]. The metabolic equivalent values per day (MET- hours/day) provide an index of energy

expenditure during a 24-hour period and can allow the evaluation of physical activity at population level.

The level of statistical significance of the observed differences was set at 5%. Weighting factors were generated by a SAS macro (version 9.3) and analyses presented in this manuscript were performed using the STATA statistical software (version 11.0 for Windows; StataCorp).

## RESULTS

Table 2 presents prevalence proportions (%) of chronic diseases (diabetes mellitus, myocardial infarction, stroke, asthma, chronic obstructive pulmonary disease, chronic

depression, permanent traumas or injuries from accidents, and chronic problems of the waist or neck) by educational level, separately by gender and for individuals below or above 65 years of age. Results are representative of the adult population in Greece (weighted percentages) and refer to self-reported diagnosis. Three out of five adult permanent residents in Greece reported suffering of a chronic disease and, as expected, the disease prevalence was higher among older participants (nine out of ten participants aged 65 years and over reported suffering from a chronic condition). Among younger individuals, females reported a chronic disease more often than males ( $p$ -value<0.001). The prevalence of chronic conditions was also higher in men and women aged <65 years of

**TABLE 2. Prevalence (%) of chronic diseases by age group and educational level, and separately by gender. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.**

	DIABETES MELLITUS			MYOCARDIAL INFARCTION			STROKE			ASTHMA		
	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
<b>Overall</b>	10.8	11.9	11.4	4.6	1.2	2.8	1.8	2.0	1.9	8.0	9.1	8.6
<b>Individuals &lt;65 years</b>	5.5	6.2	5.8	2.0	0.5	1.2	0.8	1.2	1.0	7.6	8.2	7.9
<b>Educational attainment</b>												
Low	9.8	11.5	10.7	2.8	1.0	1.8	1.5	2.4	2.0	6.6	9.3	8.1
Intermediate	3.5	4.5	4.0	1.8	0.2	1.1	0.4	0.8	0.6	8.1	8.7	8.4
High	5.4	3.2	4.3	1.6	0.3	1.0	0.7	0.4	0.6	7.5	6.1	6.8
<b>Individuals ≥65 years</b>	28.7	27.5	28.1	13.2	3.2	7.6	5.2	4.4	4.7	9.4	11.5	10.6
<b>Educational attainment</b>												
Low	29.2	29.9	29.6	13.2	3.7	7.5	4.6	5.0	4.8	11.3	12.3	11.9
Intermediate	23.5	15.3	19.5	18.0	0.0	9.3	1.7	0.4	1.1	6.9	6.5	6.7
High	31.2	9.1	25.1	8.6	0.0	6.2	11.3	1.9	8.7	2.7	7.9	4.1

**TABLE 2 (continued). Prevalence (%) of chronic diseases by age group and educational level, and separately by gender. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.**

	CHRONIC OBSTRUCTIVE PULMONARY DISEASE			CHRONIC DEPRESSION			PERMANENT TRAUMAS OR INJURIES FROM ACCIDENTS			CHRONIC PROBLEMS OF THE WAIST OR NECK		
	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
<b>Overall</b>	5.7	6.2	6.0	3.1	11.4	7.4	8.4	5.8	7.1	31.6	45.6	38.9
<b>Individuals &lt;65 years</b>	3.3	5.3	4.3	2.7	9.4	6.1	8.3	4.7	6.5	28.9	39.8	34.4
<b>Educational attainment</b>												
Low	3.2	5.7	4.6	2.9	15.8	10.0	10.9	4.9	7.6	39.2	55.4	48.1
Intermediate	3.1	5.8	4.4	3.1	7.5	5.2	7.1	4.9	6.0	26.4	34.6	30.4
High	3.9	4.1	4.0	1.8	5.5	3.7	8.3	4.3	6.3	24.2	31.7	28.0
<b>Individuals ≥65 years</b>	13.9	8.7	11.0	4.6	16.9	11.5	8.6	8.8	8.7	40.8	61.3	52.3
<b>Educational attainment</b>												
Low	13.9	8.9	10.9	4.1	16.4	11.5	7.9	8.7	8.4	41.8	63.1	54.6
Intermediate	15.7	6.3	11.2	6.9	20.5	13.5	10.0	7.0	8.6	41.4	47.4	44.3
High	12.0	9.9	11.4	4.8	17.5	8.3	11.1	13.4	11.7	35.1	57.4	41.3

**TABLE 3. Self-perceived health status (%) and reported long-term restrictions (%) in daily activities by gender or age group. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.**

	SELF-REPORTED HEALTH STATUS					LONG-TERM RESTRICTIONS IN DAILY ACTIVITIES			
	Very Good	Good	Average	Poor	Very poor	Yes, very much	Yes, little	No, not at all	Don't know / No answer
<b>Overall</b>	16.9	49.5	27.8	5.2	0.6	14.9	11.0	74.0	0.2
<b>Gender</b>									
Males	21.1	52.9	22.6	3.0	0.5	11.4	8.5	80.1	0.1
Females	13.0	46.4	32.6	7.2	0.8	18.1	13.3	68.4	0.2
<b>Age group (years)</b>									
18-64	19.9	50.7	25.3	3.5	0.6	10.6	9.2	80.1	0.1
≥65	8.0	45.9	35.3	10.1	0.7	27.6	16.2	55.9	0.4

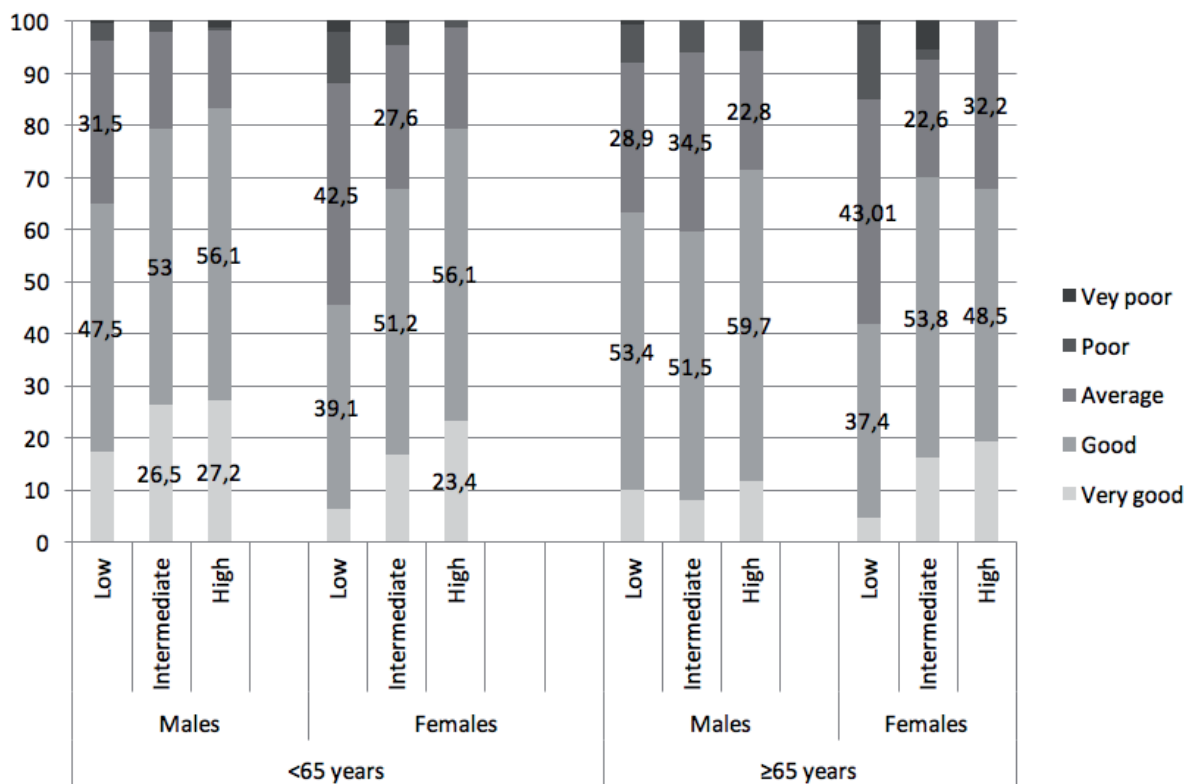
low educational attainment (data not shown). Chronic waist and neck problems among older individuals was the most frequently reported problem (about 50% among individuals above 65 years), followed by diabetes mellitus among older participants (28%), chronic depression among older women (17%), myocardial infarction (reported by 13% of older men) and asthma, including allergic asthma (reported by about 10% of the population overall). The level of completed education is considered a reliable measurable indicator of the socio-economic status of the population in Greece. Bearing that in mind, social disparities, as reflected through differences by educational levels, were identified in the prevalence of diabetes and chronic depression. In both instances, lower education and probably a lower positioning in the social ladder was associated with higher self-reported morbidity.

In Table 3 weighted frequencies of replies received towards self-perceived health and long-term restrictions on daily activities due to health problems, physical or mental, are presented by gender or age. Overall, two out of three adult permanent residents in Greece stated that their health was very good or good. The assessment of very good/good health was more common among males (74%) than females (59%) ( $p$ -value<0.001). Furthermore, one in two older individuals (65 years and over) also assessed their state of health to be good or very good. Differences in self-perceived health by educational level, separately for males and females are presented in Figure 1. At least one in ten women of low education considered their health as poor, while the proportion exceeds 14% in women over 65 years of age. The percentage of people who considered their health to be very poor, however, was in all cases negligible. Approximately one in every four adults in Greece felt restricted on his/her ordinary activities. Perceived restrictions on daily activities were more common among females (31%) than males (20%) ( $p$ -value<0.001). Figure 2 presents the weighted frequencies of perceived long-term restrictions on daily

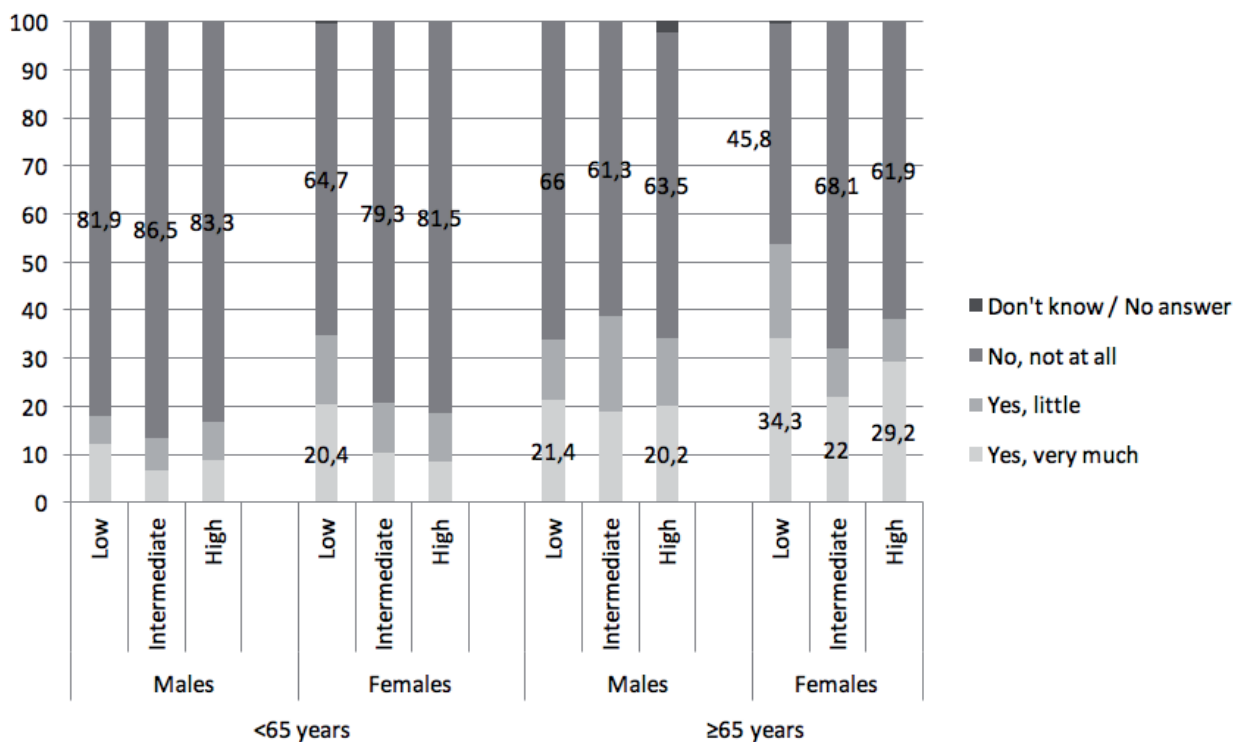
activities by gender and educational level of participants and separately for two age groups. Overall, females of low educational level and presumably lower social class perceive their personal health as poor or average (Figure 1) and experience restrictions in their daily activities more frequently than their male counterparts (Figure 2).

The mean BMI of adult permanent residents in Greece (28.7 kg/m<sup>2</sup> among males and 28.5 kg/m<sup>2</sup> among females) indicate an overweight population (Table 4). Additionally, 50% of the male population had a waist circumference equal to or greater than 99.0 cm, values which are associated with an increased risk of metabolic complications and 50% of the female population has a waist circumference measurement of 90.3 cm or greater; values that are also considered to be elevated [16]. The results presented in Table 4 highlight the problem of overweight and obesity as a major public health issue in Greece, with a total of seven out of ten adult permanent residents in the country being overweight or obese. The problem is more prevalent in men (78%) than in women (68%) ( $p$ -value<0.001). However, men are more often overweight, whereas women are more often obese. Variations in the distribution of men and women by BMI category, age group and educational level are shown in Figure 3. Overall, the proportion of obese males or females increased substantially after the age of 65 years. The figure further presents socio-economic disparities in obesity, particularly among young adults in Greece. Younger men with a higher educational level were more likely to be overweight than obese, whereas those in the low educational level were almost as often overweight or obese. Among younger women, improved education levels were associated with BMI values in the normal range. In particular, the proportion of younger women with normal BMI was nearly three times that of women in the low educational level. Both men and women in the older age group were overweight or obese, and the risk appeared to be independent of the educational level.

**FIGURE 1.** Self-perceived health status among individuals aged <65 years and ≥65 years (% by gender and educational level). Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.



**FIGURE 2.** Reported long-term restrictions in daily activities of persons aged <65 years and ≥65 years by gender and educational level. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.



**TABLE 4. Mean ( $\pm$ SD) and median (Q1, Q3) values of somatometric characteristics and frequency distributions (%) by BMI category and gender. Results are representative of the adult population in Greece (weighted). The HYDRIA survey.**

	MALES				FEMALES			
	Mean $\pm$ SD	Q1	Median	Q3	Mean $\pm$ SD	Q1	Median	Q3
Body Mass Index, BMI (kg/m <sup>2</sup> )	28.7 $\pm$ 5.0	25.3	28.1	31.3	28.5 $\pm$ 6.1	23.8	27.7	32.3
Waist circumference (cm)	99.6 $\pm$ 13.7	90.0	99.0	108.4	90.8 $\pm$ 14.9	79.0	90.3	100.2
Waist-to-hip ratio	0.95 $\pm$ 0.09	0.89	0.95	1.01	0.85 $\pm$ 0.09	0.79	0.85	0.91

**Distribution (%) of males and females by BMI <sup>a</sup> category**

	Males	Females
Underweight	0.2	1.5
Normal	22.3	31.0
Overweight	43.5	31.8
Obese	34.1	35.7

<sup>a</sup> Underweight (BMI < 18.5 kg/m<sup>2</sup>); Normal (18.5  $\leq$  BMI < 25 kg/m<sup>2</sup>); Overweight (25  $\leq$  BMI < 30 kg/m<sup>2</sup>) and Obese (BMI  $\geq$  30 kg/m<sup>2</sup>)

**TABLE 5. Mean ( $\pm$  SD), median (Q1, Q3) of the total daily energy expenditure through physical activity (MET-hours/day)<sup>a</sup>, by gender or age group. Results are representative of the adult population in Greece (weighted). The HYDRIA survey.**

	MEAN $\pm$ SD	Q1	MEDIAN	Q3
<b>Overall</b>	44.0 $\pm$ 9.6	37.3	42.1	48.1
<b>Gender</b>				
Males	43.9 $\pm$ 11.1	36.3	41.3	48.3
Females	44.0 $\pm$ 8.0	38.4	42.8	48.0
<b>Age groups (years)</b>				
18-24	41.5 $\pm$ 8.5	34.9	39.9	45.5
25-64	45.6 $\pm$ 10.1	38.7	43.7	49.9
$\geq$ 65	40.4 $\pm$ 7.2	35.7	39.5	44.2

<sup>a</sup> The calculation was based on the Compendium of Physical Activity, 2011 [14].

Table 5 presents the daily energy expenditure of adults in Greece estimated through MET-hours per day. In general, daily energy expenditure did not vary significantly between genders. Age differences in the intensity and duration of daily activities were, however, significant ( $p$ -value < 0.001).

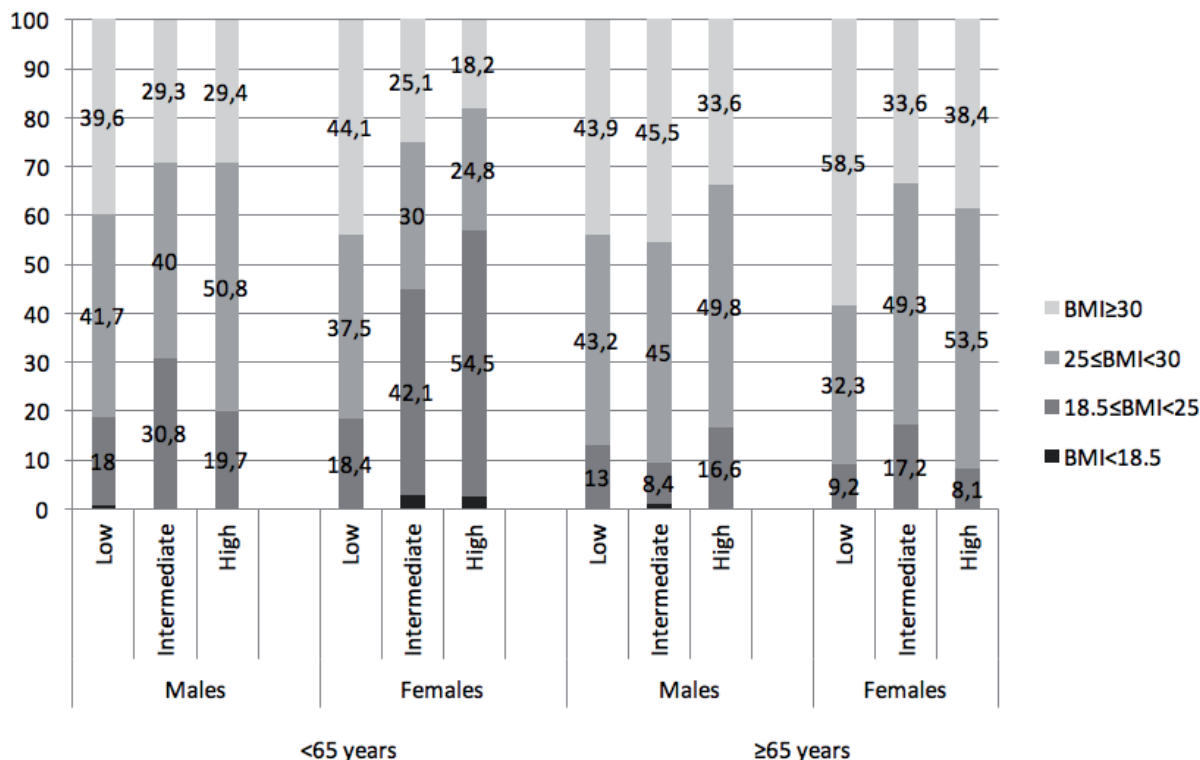
In Table 6, the weighted mean and median levels of systolic and diastolic blood pressure, heart rates, serum blood lipids and glycated hemoglobin are presented for the adult population in Greece. The large majority (75%) of the population had ideal, normal or borderline normal levels of arterial blood pressure [17]. Similarly, 75% of the population had serum total cholesterol level of less than 221 mg/dL, which is considered desirable or borderline high. The average value of the HDL-cholesterol levels was satisfactory, although 50% of the population had serum HDL levels lower than the recommended 60 mg/dL [18]. The mean glycosylated hemoglobin level of adult permanent residents in Greece is within the physiologically normal range [19-21]. Reliable conclusions regarding the

prevalence of diabetes mellitus in the population requires, however, the assessment and evaluation of additional indicators.

Approximately three in five adults in Greece indicated that they either smoke daily (32%), or occasionally (4%), or had smoked for at least one year at some point in their lives (21%) (Table 7). The smoking habit is more frequent among males than females ( $p$ -value < 0.001). In Greece, the smoking habit was still prevalent among young individuals - two in five participants aged 25-64 years reported that they smoked daily. Among men, younger individuals are more often smokers, whereas older individuals were more often former smokers. Among women, the percentage of non-smokers was higher in both age groups. However, the percentage of women who smoked daily was significantly higher in the younger age group ( $p$ -value < 0.001), reflecting probably an increase in the frequency of smoking among young women (data not shown). The prevalence of smoking among men and women by age and educational level are presented



**FIGURE 3.** Distribution (%) of individuals aged <65 years and ≥65 years by gender, Body Mass Index (BMI, kg/m<sup>2</sup>) and educational level. Results are representative of the adult population in Greece (weighted percentages). The HYDRIA survey.



**TABLE 6.** Mean (±SD) and median (Q1,Q3) values of blood pressure levels, heart rate, total and HDL<sup>a</sup> cholesterol levels and glycosylated (glycated) hemoglobin levels (GHbA1c). Results are representative of the adult population in Greece (weighted). The HYDRIA survey.

	MEAN ± SD	Q1	MEDIAN	Q3
<b>Blood pressure</b>				
Systolic blood pressure (mmHg)	124 ± 17	112	122	133
Diastolic blood pressure (mmHg)	77 ± 11	69	77	84
<b>Heart rate</b> (beats/minute)	70 ± 10	63	69	75
<b>Blood Lipids</b>				
Serum total cholesterol (mg/dl)	195.4 ± 39.2	168	193	221
HDL cholesterol (mg/dl)	58.1 ± 15.6	47	57	68
<b>Glycosylated hemoglobin, GHbA1c (%)</b>	5.3 ± 0.7	4.9	5.2	5.5

<sup>a</sup> HDL: High Density Lipoprotein

in Figure 4. In younger men, smoking seems to be more prevalent at the low educational level; at the high educational level, six out of ten men said they were former or non-smokers. Among older men, the educational level was not found to be associated with differences in smoking habits (p-value=0.243). Among women, the findings were exactly the reverse: low educated women were less likely to be smokers regardless of age; among women 65 years and older the percentage of non-smokers reaches 80%. In

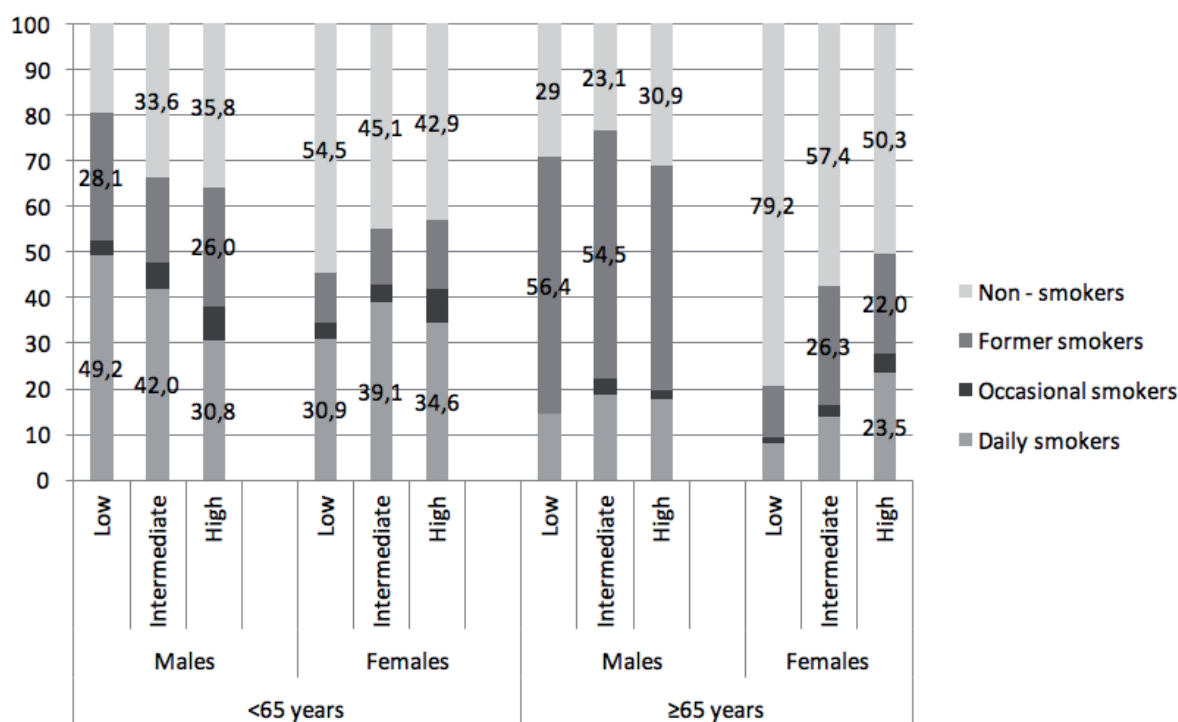
women with high educational level, (and presumably of higher socio-economic status), approximately one in four women was smoking. Improved educational attainment appears to be associated with a significant increase in the percentage of smokers in older women (p-value<0.001). In summary, the results of the HYDRIA survey provide strong evidence for socio-economic disparities in the smoking habits of women and younger men.

Table 8 presents the prevalence of mortality risk

**TABLE 7. Smoking habits (%) of the adult population in Greece. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.**

	CURRENT SMOKERS		FORMER SMOKERS	NON-SMOKERS
	Daily	Occasionally		
<b>Overall</b>	31.6	4.1	21.2	43.1
<b>Gender</b>				
Male	34.9	4.5	30.4	30.2
Female	28.5	3.8	12.8	54.9
<b>Age group (years)</b>				
18-24	27.6	10.0	4.2	58.1
25-64	39.4	4.5	19.4	36.7
≥65	12.1	1.3	31.8	54.9

**FIGURE 4. Distribution (%) of individuals aged <65 years and ≥65 years by their smoking habits, gender and educational level. Results are representative of the adult population in Greece (weighted percentages). The HYDRIA survey.**



factors (hypertension, hypercholesterolemia, low serum levels of HDL-cholesterol, smoking and obesity) by age, educational attainment and separately by gender. The percentages presented in this table provide the distribution of participants per indicated contrasts. Hence, according to this table, 39.6% of young males (18-24 years old) smoke, whereas 60.4% were not smokers. Similarly, 35.7% of young females (18-24 years old) reported smoking and 64.3% did not smoke. Table 8 reveals the higher prevalence of mortality risk factors among individuals aged 25-64 years and low educational attainment. In general,

adults above 25 years of low education and presumably of lower social class reported more frequently disease conditions and lifestyle choices which are associated with premature mortality. Gender differences are also apparent. The prevalence of risk factors is generally higher among males aged 25-64 years as compared to their female counterparts and differences are substantial in the case of hypertension and low levels of serum HDL. Gender differences narrow among individuals above 65 years and are reversed in the case of obesity with the prevalence being higher among older women than men.

**TABLE 8. prevalence (%) of mortality risk factors by gender, age group and educational level. Results are representative of the adult population in Greece (weighted %). The HYDRIA survey.\***

	HYPERTENSION <sup>a</sup>		HYPERCHOLESTEROLEMIA <sup>b</sup>		LOW SERUM HDL <sup>c</sup>		SMOKING <sup>d</sup>		OBESITY <sup>e</sup>	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
<b>Overall</b>	45.8	37.9	13.9	13.0	16.0	3.8	39.4	32.3	34.1	35.7
<b>Individuals 18-24 years</b>	8.6	1.1	2.3	0.4	7.3	2.2	39.6	35.7	11.3	8.2
<b>Educational Level</b>										
Low	0.0	9.9	0.0	0.0	0.0	0.0	49.6	5.0	0.0	18.9
Intermediate	9.3	1.0	2.4	0.5	8.4	2.6	39.3	37.1	11.2	8.3
High	12.9	0.0	5.6	0.0	0.0	0.0	24.4	32.9	40.6	5.1
<b>Individuals 25-64 years</b>	38.2	23.8	16.4	14.5	17.4	4.4	47.2	40.8	34.4	31.3
<b>Educational Level</b>										
Low	50.2	40.0	22.7	21.3	21.4	4.6	52.8	34.9	41.3	44.4
Intermediate	34.1	19.4	16.0	12.9	15.5	5.5	49.8	44.3	33.8	29.5
High	33.9	11.3	11.6	9.1	16.8	2.6	38.4	42.3	29.2	19.0
<b>Individuals ≥65 years</b>	82.4	83.3	10.6	13.1	15.1	2.6	16.4	10.9	42.6	55.1
<b>Educational Level</b>										
Low	83.8	85.7	10.6	12.1	17.5	2.8	14.6	9.5	43.9	58.5
Intermediate	75.6	71.7	12.9	18.2	12.8	0.9	22.5	16.3	45.5	33.6
High	81.4	60.7	8.2	19.6	5.9	3.1	19.6	27.7	33.6	38.4

\* Numbers do not sum up as they provide the percentage of individuals per each contrast (e.g. hypertension yes vs. hypertension no). For example, 8.6% of males aged 18-24 years bear indications of hypertension, whereas 91.4% of males aged 18-24 years do not bear indications of hypertension.

<sup>a</sup> Evidence of hypertension was established based on the existence of at least one of the following criteria: (a) a self-reported previous diagnosis (b) an individual under medication to treat hypertension (c) raised mean blood pressure values after three measurements, particularly systolic blood pressure of  $\geq 140$  mmHg and/or diastolic blood pressure of  $\geq 90$  mmHg.

<sup>b</sup> Serum Total Cholesterol levels  $\geq 240$  mg/dl [17].

<sup>c</sup> Levels of HDL serum cholesterol  $< 40$  mg/dl [17].

<sup>d</sup> Current smokers (daily or occasionally)

<sup>e</sup> Obesity defined as  $BMI \geq 30$  kg/m<sup>2</sup>

## DISCUSSION

The HYDRIA study, the first nationally representative health and nutrition survey including a large sample of the adult population in Greece provides robust evidence for the health and nutrition status of the population and the prevalence of conditions which are related to premature death and disability [22-25]. According to the results of the HYDRIA study, in 2013-14 three out of five adult permanent residents in Greece reported suffering of a chronic disease, with diabetes mellitus and chronic depression being among the more frequent ones in older individuals. Furthermore the population in Greece has been experiencing an overweight/obesity epidemic, since 7 out of 10 adults in the country are either overweight or obese. Smoking is still common in the population and among women the prevalence was higher in younger

age groups. Excess body weight, the smoking habit and the population's limited physical activity are the predominant challenges that Greek public health officials have to deal with in formulating policies and designing actions. In addition, social disparities were observed in the prevalence of chronic diseases and of their established risk factors (hypertension, obesity, impaired lipid profile and high blood glucose levels). A lower positioning in the social ladder was associated with higher self-reported morbidity, obesity and smoking (among older men), a lower perception of personal health (particularly among women) and with a more frequent feeling that daily activities were restricted. Among women and younger men, however, the association between smoking and social class was reverse - individuals of higher socio-economic status were more frequently smokers than those in lower social class.

Our results confirm the findings of smaller regional

studies in Greece, in relation to the high prevalence of obesity, hypertension, lack of physical activity and smoking [4-9]. In the 1990s, the large EPIC study recruiting approximately 30,000 subjects in Greece reported that 75% of men and 28% of women were current or former smokers [3]. In 2013-14, the nationally representative HYDRIA study reports a similar proportion of male smokers in the population, while the proportion of female smokers has increased particularly among highly educated women.

The national representativeness, ensured through multistage random sampling based on the most recent population census and the application of a standardized protocol are strengths of the HYDRIA survey. The fieldworkers have been following intensive and regular training programs to ensure the repeatability of procedures, which were also centrally organized and monitored through a tight quality control system. Data collection included interviewer-administered questionnaires as well as measurements of somatometric characteristics to diagnose overweight or obesity and blood drawing. Moreover, the application of a harmonized among EU Member States protocol generated dietary and other health-related data which are directly comparable to those of other European countries. The HYDRIA is a prevalence study, and as such, cannot be used for causal inferences, but it provides the background material to identify problems with significant predictive value for the future health of the population in the country and to initiate targeted surveillance actions.

Health policy measures are generally directed towards disease therapy and the corresponding necessary infrastructure. Measures and procedures that focus on areas related to disease prevention rather have the potential to impact more on health indices than investment in high technology, which nevertheless, is also required. Any attempt to effectively address and improve public health problems includes short and long-term measures. Both should be based on systematic mapping of the problem, prioritisation of potential alternatives or complementary measures, implementation according to the best known practices and lastly but not least, the evaluation of their efficiency.

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## Disclaimer

Results have been produced to the requirements of the "HYDRIA. Programme and targeted action on the diet and health of the Greek population: development and implementation of methodology and documentation" project and represent the views of the authors. These views have not been adopted nor in any way approved by the Department of Special Services of the Hellenic Ministry of Health and Social Solidarity or the European Commission and should not be regarded as the position of the Ministry or the Commission. The Ministry does not guarantee the accuracy of the information contained in this publication, nor does it accept any responsibility for the use of any of this information.

## Ethics approval and consent to participate

The HYDRIA survey was approved by the Hellenic Health Foundation's Committee on Bioethics and informed consent were obtained from all participants, in accordance to the Helsinki Declaration.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

GM, AN, MP and PO were responsible for the analysis and interpretation of the data. GM and AN drafted the manuscript. MP, EP and AT contributed to the data acquisition and revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

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