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Evidence-Based Public Health 2017

Lead Guest Editor: Giedrius Vanagas
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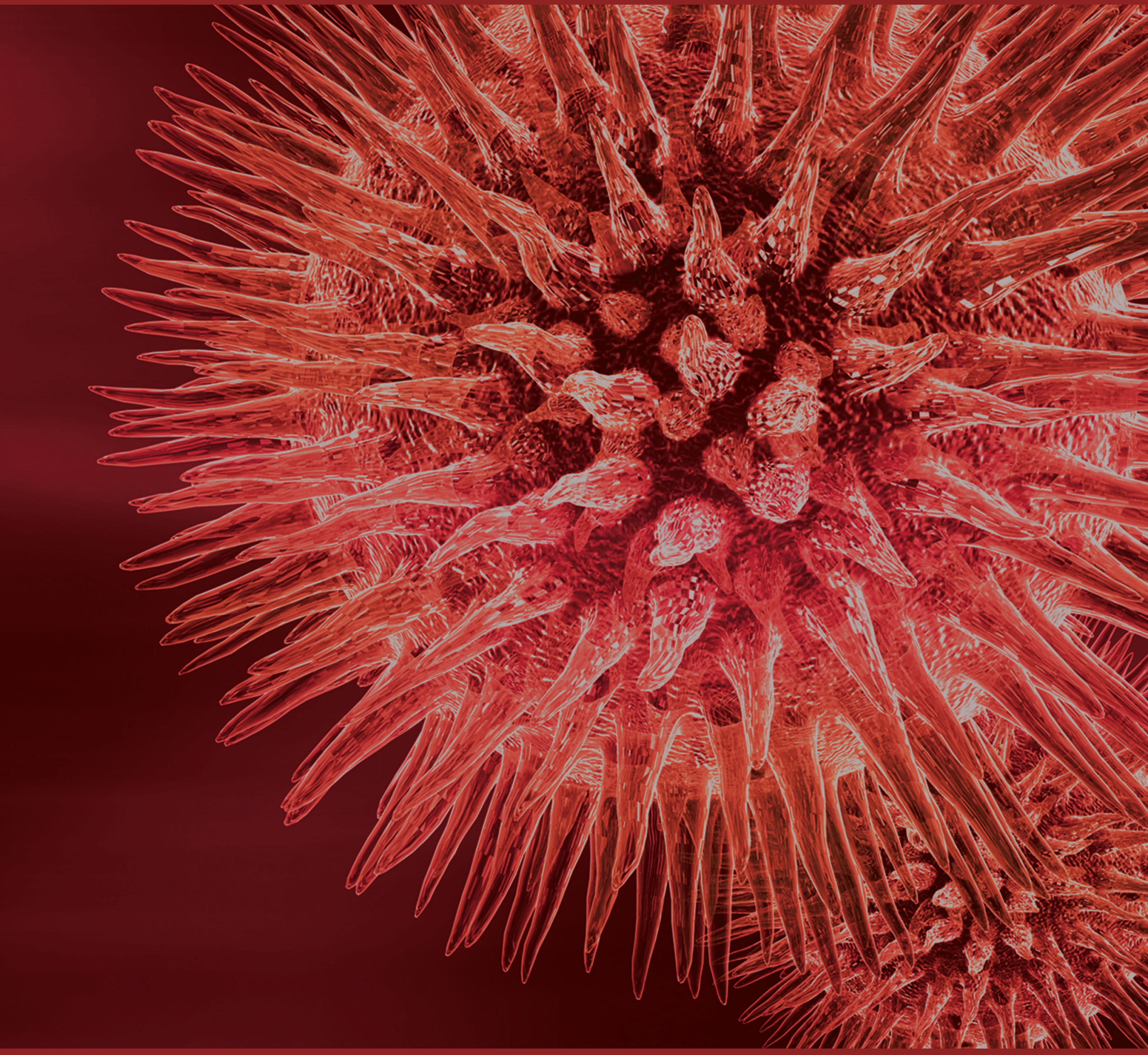

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Editorial

Evidence-Based Public Health 2017

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Public health science has made considerable advances in its aim to improve scientific standards in order to generate well-grounded evidence. One of the principles to promote higher standards in public health is methodological development in the field of evidence-based public health (EBPH) [1–6]. EBPH can be defined as a process of integrating evidence from scientific research and practice to improve the health of the target population.

The key components of EBPH include making decisions on the basis of the best available scientific evidence and using sound data collection and research methods together with engaging the community in the decision-making. An EBPH approach could potentially have numerous direct and indirect benefits, including access to more and higher-quality information on best practice, a higher likelihood of successful prevention programs and policies, greater workforce productivity, and more efficient use of public and private resources.

The most critical problem for EBPH is the absence of evidence and the lack of a conceptual framework regarding how much evidence is sufficient to judge and evaluate our policy decisions. Often, we have evidence that something should be done (e.g., needs of assessment, measures of prevalence, and preventability of risks and conditions) but, in most cases, we lack evidence regarding what should be done (e.g., the effectiveness of health intervention) or how to do it (e.g., evaluation of the health process) [7]. From this viewpoint, our special issue has addressed some important aspects and shows the increasing importance of EBPH as a research field in its own right.

The study by A. Berke-Berga et al. provided evidence for the development of insightful health policies in the case of Latvia. Their study examined the evolution of distributional differences in perceived health status in recent years and, based on the empirical evidence, the authors concluded that a favorable health inequality index does not confirm a reduced burden of unavoidable inequalities in health in the worse-off group of the population and the relative contributions of SES-related determinants to the production of change in health inequalities over time. Their study generates evidence for insightful health policy development.

The economic impact of cancer is enormous for both the person with cancer and for society as a whole. Vietnam is now implementing the National Strategy for Cancer Control up to 2020. Cancer prevention and control in Vietnam are still facing several challenges, such as a lack of comprehensive actions from the involved stakeholders, the unavailability of services for cancer screening, and early detection at the grass-roots level of care, as well as a shortage of human capacities and financial resources. Households belonging to the poor or poorest socioeconomic groups are significantly associated with increased impoverishment due to their healthcare costs related to treatment [8]. The study by V. M. Hoang et al. generates new evidence regarding the financial burden on households and the impact of poverty on cancer treatment in Vietnam. Given the evidence, policy actions that can reduce/remove the financial barriers and provide financial protection for cancer patients (as well as other population groups) are urgently required.

The study by K.-S. Bang et al. explored the health status and health-related quality of life of rural elderly Vietnamese and assessed their needs for healthcare services. The results of this study reveal epidemiological patterns in Vietnam, shifting from a predominance of communicable diseases to noncommunicable diseases. The role of the healthcare provider in rural areas should be strengthened to effectively address the need for healthcare services of the elderly population, as well as appropriate health education to promote healthy lifestyles. Further research is required to promote evidence-based health policy development for chronic illness management programs for the rural elderly in Vietnam.

Developing countries face the dual burden of both undernutrition and overnutrition simultaneously, exerting substantial strain on the already overburdened health systems. The prevalence of overweight and obesity has increased manyfold in Asia, especially in South Asia. The study by I. Khan et al. found a significant dose-response relationship of increasing comorbidities with increasing weight. The association has important implications for public health planning and management, as the health effects of obesity at the individual and community levels manifest through these comorbid states, which are often known to increase in proportion with increasing weight.

Climbers, workers, and tourists who travel to high-altitude destinations are at risk of altitude illness due to hypoxia. The most common form of altitude illness is acute mountain sickness (AMS). Previous epidemiological studies on the relationship between smoking and AMS risk yielded inconsistent findings. Therefore, a meta-analysis of observational studies (cross-sectional studies, case-control, or cohort studies) was performed by C. Masuet-Aumatell et al. to determine whether smoking was related to the development of AMS. The meta-analysis contains 11 full-text studies on smoking and AMS, including 7 cross-sectional studies, 3 cohort studies, and 1 case-control study.

This annual issue continues our efforts to provide relevant evidence and tools for public healthcare practitioners. Finally, with this issue we are aiming to stimulate the application of evidence-based knowledge to the practice of public health and public health decision-making.

Acknowledgments

The guest editors of this special issue thank the reviewers and all the authors for the important contributions they have made to this issue.

Giedrius Vanagas
Malgorzata Bala
Stefan K. Lhachimi

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Review Article

Relationship between Smoking and Acute Mountain Sickness: A Meta-Analysis of Observational Studies

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Aims. Previous epidemiological investigations of the relationship between smoking and acute mountain sickness (AMS) risk yielded inconsistent findings. Therefore, a meta-analysis of observational studies was performed to determine whether smoking is related to the development of AMS. *Methods*. Searches were performed on PubMed, Scopus, Embase, and Web of Science for relevant studies that were published before November 2016 reporting smoking prevalence and AMS. Two evaluators independently selected studies, extracted data, and assessed study quality. The pooled relative risks (RRs) and 95% confidence intervals (CIs) were obtained using random-effects models. Subgroup analyses were performed according to the type of participant, altitude, and study design. *Results*. A total of 11 observational studies involving 7,106 participants, 2,408 of which had AMS, were eligible for inclusion in this meta-analysis. The summary RR for AMS comparing smokers to nonsmokers was 1.02 (95% CI: 0.83 to 1.26). Specific analyses for altitude, type of participant, and study design yielded similar results. There was significant heterogeneity for all studies ($Q = 37.43$; $P < 0.001$; $I^2 = 73\%$, 95% CI: 51% to 85%). No publication bias was observed (Egger's test: $P = 0.548$, Begg's test: $P = 0.418$). *Conclusions*. The meta-analysis indicates that no difference was found in AMS risk with regard to smoking status.

1. Introduction

Climbers, trekkers, workers, and tourists who travel to high-altitude destinations are at risk of altitude illness due to hypoxia. Altitude illness, which includes acute mountain sickness (AMS), high-altitude cerebral edema (HACE), and high-altitude pulmonary edema (HAPE), may occur in any traveller who reaches 2,500 meters above sea level (MASL) or higher if inadequate acclimatisation occurs [1]. Millions of people travel to typical high-altitude destinations annually, such as Cuzco (3400 MASL, Peru), La Paz (3780 MASL, Bolivia), Lhasa (3660 MASL, Tibet), Everest Base Camp (5364 MASL, Nepal), and Kilimanjaro (5895 MASL, Tanzania).

The most common form of altitude illness is AMS, which generally resolves within 24–72 hours of acclimatisation. The incidence of AMS varies from 25% to 75% [1] in the general population but is unknown in smokers. AMS risk is affected by a traveller's characteristics such as genetic traits [2], age [3], previous exposures to high altitude and experience [4], destinations, itinerary, rate of ascent, and exertion [5]. Alcohol intake avoidance [4], carbohydrate ingestion [6], water intake [7], and acetazolamide use [8] may prevent AMS. Training or physical fitness may not be significantly associated with AMS, but the influence of some covariates, such as obesity or smoking status, is debatable. High altitudes cause a decrease in barometric pressure and inspired oxygen pressure. Therefore, reduced alveolar oxygen pressure, oxygen arterial pressure, and oxygen arterial saturation rate occur, which greatly reduces oxygen availability into tissues.

Smoking tobacco increases the carbon monoxide (CO) concentrations in the airways and the blood. Carbon monoxide's haemoglobin-binding affinity is over 200 times that of oxygen. The level of CO is an indirect measure of blood carboxyhaemoglobin (COHb). The percentage of COHb is the proportion of red blood cells carrying CO instead of oxygen. The normal level of CO for a nonsmoker depends on background levels in the air but is usually lower than 5 ppm, and percent of COHb is lower than 1.43 [9]. The level of CO for a smoker is usually much higher according to the time of the day, the number of tobacco products smoked, and how the smoke is inhaled. The level of CO for a smoker of 20 cigarettes per day is usually around 20 ppm and percent of COHb higher than 3.83. Increased levels of carbon monoxide in the bloodstream have a negative ionotropic effect [10] and can limit the amount of oxygen transported in muscular capillaries, which adversely affects skeletal muscle performance. Smoking causes an increase in carboxyhaemoglobin levels, resulting in a leftward shift of the oxyhaemoglobin dissociation curve when carbon monoxide is present in the blood. Carbon monoxide reduces the formation of 2,3-DPG by inhibiting glycolysis in the erythrocyte. Nicotine stimulates the sympathetic nervous system, which can lead to increased levels of catecholamine, thereby increasing a person's heart rate and stroke volume [11]. The tar produced by the burning of tobacco can increase pulmonary airway resistance or reduce the contact surface area between oxygen and pulmonary capillaries, thereby decreasing the capacity of the arteries to transport oxygenated blood during exercise. Therefore, smokers exhibit a lower capacity to transport oxygen because of increased carboxyhaemoglobin and difficulties in breathing control and alterations in vascular tone, neurotransmission, and cellular metabolism due to carbon monoxide and lower vasodilatation in hypoxic environments than nonsmokers [11].

Previous epidemiological investigations of the relationship between smoking and acute mountain sickness (AMS) risk yielded inconsistent findings. Some studies identified smoking as a risk factor [12, 13] or a protective factor [11, 14], but other studies failed to show any significant association [4, 15–18]. However, only one study was specifically designed to study smoking as a risk factor for AMS [11]. Therefore, a meta-analysis of observational studies (cross-sectional studies, case-control or cohort studies) was performed to determine whether smoking was related to the development of AMS.

2. Materials and Methods

2.1. Data Sources and Search Strategy. The PRISMA statement [19] for the reporting of systematic reviews recommended by the Cochrane Collaboration was followed while conducting this meta-analysis (see Figure 1). Observational studies (cross-sectional studies, case-control, and cohort studies) on smoking and the risk of AMS were included in our meta-analysis, and language, publication status, or article type was not considered. Two investigators conducted a systematic literature search of the electronic databases PubMed (from 1965 to November 2016), SCOPUS (from 1965 to November 2014), Embase (from 1965 to November 2016), and Web of Science (from 1986 to November 2016). Searches were performed using the search terms under two search themes that were combined using the Boolean operator "AND." For the theme of "AMS," a combination of Medical Subject Headings (MeSHs), entry terms, and text words was used: "acute mountain sickness," "altitude illness," "mountain sickness," "high-altitude cerebral edema," and "HACE." For the theme of "Smoking," "smoking" and "tobacco" were used. In addition, all references cited in relevant original and review articles were searched manually.

2.2. Selection Criteria. Eligible studies met the following inclusion criteria: (1) the study was an observational study (cross-sectional study, case-control study, nested case-control study, or cohort study); (2) the exposure of smoking was described; (3) the outcome of interest was AMS; (4) the study reported the percentage of AMS according to tobacco exposure, the relative risk (RR) or odds ratio (OR), and the 95% confidence interval (CI) for the association between smoking and risk of AMS; and (5) a Newcastle-Ottawa Scale (NOS) or adapted Newcastle-Ottawa Scale (aNOS) score of 5 or greater indicated moderate- to high-quality studies [20]. Studies that did not document the frequency of AMS, animal experimentation studies, and mechanistic research studies were excluded. Studies in which the exposure of interest was not sufficiently explained were also excluded to avoid the combination of studies that were not comparable. Two investigators independently conducted the study selection.

2.3. Data Extraction and Quality Assessment. Two reviewers independently performed data extraction and quality assessment. The following information was extracted from each eligible study: first author's surname, year of publication, study location, study design, source of study population, type of exposure or population, sample size, number of events, proportion of smokers, definition of smoking, definition of AMS, estimated effect size (OR or RR), 95% CI, and covariates adjusted in statistical analyses. No studies reported several multivariable-adjusted effect estimates based on smoking behaviour. Therefore, a result that was fully adjusted for potential confounding variables was not selected. Quality assessment was conducted using the nine-star Newcastle-Ottawa Scale (NOS); see Table 1. We considered studies with an NOS score of 5 or greater to be moderate- to high-quality studies [20]. After data extraction and assessment, the information was examined and adjudicated independently by an investigator who referred to the original articles.

2.4. Statistical Analysis. The relationship between smoking and risk of AMS was examined using the OR or RR and 95% CI in each study or the frequency of AMS in smokers versus nonsmokers. Prevalence ratios (PRs) in the cross-sectional studies and the OR in case-control studies approximated the RR because the absolute risk of AMS is low [21]. The AMS detected was the incidence of AMS in all cross-sectional studies because these studies asked about the appearance of AMS when the subjects reached the altitude where the study was conducted. The incidence of AMS and its 95% CI was described depending on smoking status and altitude. Therefore, the PRs and ORs should likely be considered RRs in these studies. A meta-analysis comparing the risk of AMS between smokers and nonsmokers in all included studies was performed. Smokers were defined as subjects who smoked 10 or more cigarettes per day currently. Mountaineers were defined as trekkers or climbers who were physically fit

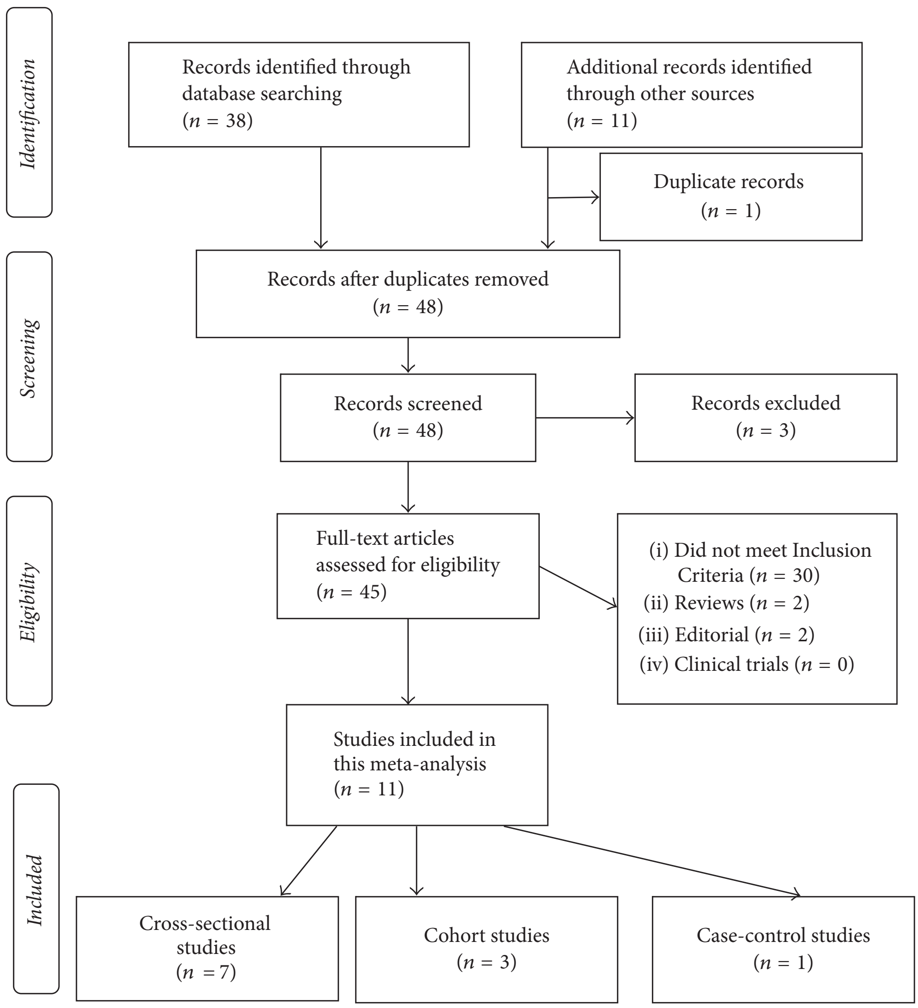


Figure 1: PRISMA flow chart of the included studies selection process.

Table 1: Characteristics of included studies according to Newcastle-Ottawa Quality Assessment Scale.

Study	Selection	Comparability	Exposure/ outcome	NOS scale
Wu et al., 2012	⋆⋆⋆	⋆	⋆⋆	6
Li et al., 2011	⋆⋆⋆	⋆⋆	⋆⋆	7
Wagner et al., 2008	⋆⋆⋆	⋆	⋆	5
You et al., 2012	⋆⋆⋆	⋆⋆	⋆⋆	7
Vinnikov et al., 2014	⋆⋆⋆	⋆	⋆⋆	6
McDevitt et al., 2014	⋆⋆⋆	⋆	⋆	5
Mairer et al., 2009	⋆⋆⋆	⋆	⋆	5
Mairer et al., 2010	⋆⋆⋆	⋆	⋆	5
Mairer et al., 2010	⋆⋆⋆	⋆	⋆	5
Schneider et al., 2001	⋆⋆⋆	⋆	⋆	5
Schneider et al., 2001	⋆⋆⋆	⋆	⋆	5

Note. Each star represents a high-quality criterion accomplished by the study.

persons, who knew the rules of high-altitude climbing, and were aware of the importance of acclimatisation. AMS was defined as an Environmental Symptom Questionnaire (ESQ) score greater than 0.7 [22]; Lake Louise score (LLS) greater than or equal to 3 [23]; or using a Study-Specific Questionnaire (SSQ) [12, 15, 24]. If a single study reported results for different populations (e.g., different altitudes or destinations) but did not report the overall results, the results for each population were calculated as a separate study [25]. The ESQ has 67 questions, evaluates the presence and severity of AMS symptoms (headache, nausea, and the general feeling of ill health), and determines whether an individual has no AMS (ESQ < 0.7) or AMS (ESQ ≥ 0.7). The ESQ contains many superfluous questions, requires multiplying each response by a factorial weight, and has been criticised because it is validated against the simple item, "I feel sick." The LLS has five questions, evaluates the presence and severity of AMS symptoms (headache, gastrointestinal symptoms, fatigue and weakness, dizziness and light-headedness, and difficulty sleeping), and determines whether an individual has no AMS (LLS < 3), mild AMS (LLS 3–5), or severe AMS (LLS $>$ 5). The LLS has been validated against clinical assessment. Some studies show that for criterion scores yielding similar prevalence of AMS, ESQ labels 20% of cases differently when compared to LLS. The SSQ means that each study used a specific questionnaire as a translation of a Chinese scoring system for AMS [15, 24], which presents a high correlation to LLS ($r = 0.820$) or restricted the case definition of AMS to those persons who were deemed ill enough to undergo compression chamber treatment [12]. Reported incidences and identifiable predictive factors of AMS [26] depend on study design (RCTs in comparison to cohort and cross-sectional studies). Subsequently, we conducted subanalyses by epidemiological study design (cross-sectional studies and case-control studies versus cohort studies), altitude (high altitude defined as <3500 MASL versus very high altitude defined as ≥3500 MASL) [11], type of participant characteristics (mountaineers versus nonmountaineers), and NOS (≥6 versus <6) as a sensitivity analysis. According to inclusion criteria, NOS < 6 refers to NOS = 5. All included studies presented different quality assessment scores. Therefore, we performed sensitivity analyses according to NOS score and designated NOS scores from 5 to 6 as moderate and NOS scores equal to or greater than 7 as high. A random-effects model was used to estimate the pooled RRs with 95% CIs because there was evidence of heterogeneity [27]. Forest plots were used to assess the RR estimates and corresponding 95% CIs visually. We could not perform a two-stage, random effect, dose–response meta-analysis to examine the potential nonlinear relationship between smoking dose and risk of AMS because smoking dose was not reported in most studies. Heterogeneity between studies was evaluated using the Cochran's Q and I^2 statistics [28, 29]. The probability of publication bias was assessed using the Egger regression test [30] and Begg's funnel plot [31]. We evaluated the effect of publication bias using the trim and fill method [32]. Stata version 12.0 software (Stata Corporation, College Station, TX) was used for all analyses, and all statistical tests were two-sided. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Description of the Selected Studies. Forty-nine records were retrieved using the specified search strategy in November 2016. After reading the titles and abstracts, 4 records were excluded, and 45 studies were retained for further evaluation by a reading of the full text. Thirty-four studies did not meet the inclusion criteria or were not an original study. Finally, we identified 11 full-text studies on smoking and AMS for inclusion in the meta-analysis, including 7 cross-sectional studies [4, 13, 16–18], 3 cohort studies [11, 14, 15], and 1 case-control study [12]. Figure 1 depicts the search process. These 11 studies included 7,106 participants and 2,408 AMS cases (5 studies in Asia; 5 studies in Europe; and 1 study in America). Table 2 presents the general characteristics of the included studies. Studies asked the same fundamental question about risk factors linked to AMS, but the populations (mountaineers, tourists, workers, and military troops), study design (cross-sectional studies, nested case-control study in an occupational cohort, and cohort studies), AMS definition, and smoking status definition were not identical. Therefore, the studies varied in specific ways.

3.2. Description of the AMS Incidence. The overall incidence of AMS in the studied population was 25.02% (95% CI, 24.01 to 26.03); when they climbed to altitudes between 2500 MASL and 3500 MASL, it was 19.61% (95% CI, 16.16 to 23.06); higher than 3500 MASL, it was 25.44% (95% CI, 24.39 to 26.49); if they were climbers or mountaineers, it was 34.31% (95% CI, 32.50 to 36.12); and, in nonmountaineers, it was 19.54% (95% CI, 18.38 to 20.70).

3.3. Smoking and Risk of AMS. Figure 2 shows the summary RR of AMS for smoking status. The summary RR for smokers was 1.02 (95% CI, 0.83 to 1.26) for AMS, with some heterogeneity ($I^2 = 73.0\%$, $P < 0.001$). The Begg's funnel plot did not show any asymmetry ($P = 0.418$), and Egger's test revealed no publication bias ($P = 0.548$).

3.4. Subgroup Analysis. Table 3 shows the results of subgroup analyses according to study design, altitude, quality assessment of the studies, and type of participant. The reported RR always was considered smoking over nonsmoking. Restriction of analysis to cohort studies revealed a summary RR of AMS for smoking status of 0.79 (95% CI, 0.54 to 1.17) with high heterogeneity ($I^2 = 89.0\%$, $P < 0.001$). Two cohort studies showed a statistically protective effect of smoking on AMS development. The RR for AMS risk for case-control or cross-sectional studies was 1.20 (95% CI, 0.99 to 1.47) without heterogeneity ($I^2 = 32.0\%$, $P = 0.169$). Two of these studies showed a significant risk effect of smoking on AMS development. Stratification by altitude revealed an RR for AMS of 1.24 (95% CI, 0.78 to 1.95) without heterogeneity ($I^2 = 25.0\%$, $P = 0.922$) for altitudes below 3500 MASL and an RR of 1.00 (95% CI, 0.79 to 1.26) with some heterogeneity ($I^2 = 78.0\%$, $P < 0.001$) for altitudes equal to or above 3500 MASL. However, controversial association results were present. The RR for AMS according to type of exposure or population was 1.17 (95% CI, 0.97 to 1.41) without heterogeneity ($I^2 = 23.0\%$, $P = 0.253$) for mountaineers or in studies with moderate quality (NOS = 5 or aNOS = 5) and 0.92 (95% CI, 0.62 to 1.36) with high heterogeneity ($I^2 = 87.0\%$, $P < 0.001$) for nonmountaineers (travellers, workers, or military troops) or in studies of high quality (NOS ≥ 6 or aNOS ≥ 6).

3.5. Sensitivity Analysis. Table 4 shows the results of sensitivity analyses. The sensitivity analysis removed one study at a time to assess the robustness of the overall results. Sensitivity analyses and subgroup analyses results were consistent with the overall results, which indicated that there was no heterogeneity from study design, study quality, altitude, or type of participants. However, one study [14] decreased statistically significant the heterogeneity to 59%, probably because it is a military cohort study conducted in China at an altitude over 4300 MASL, and the AMS definition was LLS ≥ 4.

4. Discussion

The meta-analysis indicates that no difference was found in AMS risk with regard to smoking status (RR 1.02, 95% CI,

Table 2: Characteristics of included studies.

Study	Final altitude (MASL)	Design	n	Smoking	AMS	Smoking adjustment
Wu et al., 2012	4552 *MASL* (4292–4905 *MASL*), Qinghai-Tibet railroad; occupational cohort	Cohort study	382	Smoking status: (i) No smoker (ii) Smoker < 20 cig/d (iii) Smoker 20 cig/d (iv) Smoker > 20 cig/d	LLS ≥ 4	Absent
Li et al., 2011	(2900–4300 *MASL*); Qinghai Tibet plateau; military cohort	Cohort study	3727	Smoking status: (i) No current smoker (ii) Current smoker	SSQ	Present
Wagner et al., 2008	4419 *MASL* (2550–4419) Mt. Whitney, California, USA; Hikers	Cross-sectional	886	Smoking status: (i) Smoker (ii) Nonsmoker	LLS ≥ 3	Absent
You et al., 2012	4300 *MASL* (2860–5250 *MASL*); Military cohort	Cohort study	314	Smoking status: (i) Not current smoker (ii) Current smoker	LLS ≥ 4	Present
Vinnikov et al., 2014	4000 *MASL* (3800–4200 *MASL*) Tyan Shan Mountains, Kyrgyzstan; Occupational cohort	Nested case-control (1 : 2)	45	Smoking status: (i) Smoker <10 cig/d (ii) Smoker ≥10 cig/d (iii) Nonsmoker	SSQ	Absent
McDevitt et al., 2014	(3500–5400 *MASL*); Thorong-La, Annapurna, Nepal; Trekkers	Cross-sectional	332	Smoking status: (i) Smoker (ii) Nonsmoker	LLS ≥ 3 LLS ≥ 5 ESQ > 0.7	Present
Mairer et al., 2009	2200–3500 *MASL* Eastern Alps; Mountaineers	Cross-sectional	431	Smoking status: (i) Smoker (ii) Nonsmoker	LLS ≥ 4	Absent
Mairer et al., 2010	3454-4049 *MASL* in Eastern Alps; Mountaineers	Cross-sectional	79	Smoking status: (i) Smoker (ii) Nonsmoker	LLS ≥ 4	Absent
Mairer et al., 2010	3817-4808 *MASL* in Western Alps; Mountaineers	Cross-sectional	83	Smoking status: (i) Smoker (ii) Nonsmoker	LLS ≥ 4	Absent
Schneider et al., 2001	4559 *MASL*; Capanna Margherita, Italy; Mountaineers in 1996 and 1999	Cross-sectional	440	Smoking status: (i) No smoking (ii) Smoking	ESQ > 0.7	Present
Schneider et al., 2001	4559 *MASL*; Capanna Margherita, Italy; Mountaineers in 2000	Cross-sectional	387	Smoking status: (i) No smoking (ii) Smoking	ESQ > 0.7	Present

SSQ: study-specific questionnaire; AMS: acute mountain sickness; ESQ: environmental symptom questionnaire; NS: not stated; LLS: Lake Louise Score.

0.83 to 1.26) independent of altitude, training, or type of questionnaire used.

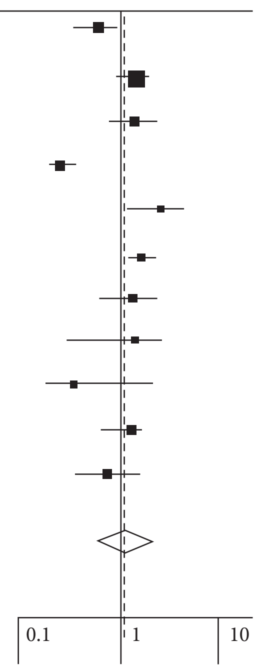
4.1. Smoking. Smoking status is thought to participate in acute mountain sickness, and it is considered a traditional risk factor for the development of AMS [1, 11]. However, some epidemiological studies that evaluated the development of AMS did not describe smoking as a risk factor, and most epidemiological studies were not specifically designed to evaluate the relationship between smoking and AMS. These studies describe controversial results because negative and positive associations are reported. This lack of agreement between the results of previous studies may be due to differences in altitude, study population, epidemiological designs, or residual confounding. Previous studies were systemically reviewed to explore the association between smoking and the risk of AMS because of the importance of this possible association in clinical practice and public health. To our knowledge, prior to our study, two meta-analyses explored the association between smoking and AMS [33, 34] with different results. Vinnikov et al., 2016, found that smoking was not significantly associated with AMS (OR 0.88, 95% CI, 0.74 to 1.05) whereas Xu et al. [34] found that smoking may protect against AMS development (OR 0.71, 95% CI, 0.52 to 0.96). Different selection criteria may lead to different results; we used strict inclusion criteria, high-quality studies, and control for confounding variables and heterogeneity by different methodological tools. Our meta-analysis results contrast with one meta-analysis [34] but accord with the other one [33]. Meta-analysis of 11 observational studies suggested an AMS incidence rate of 25.02%, being lower if the traveller climbed below 3500 MASL

Table 3: Subgroup analyses of RRs for the association between AMS and smoking.

Group	Number of studies	Pooled RR (95% CI)	Heterogeneity	
			I^2	P
Overall	11	1.02 (0.83, 1.26)	73.0%	<0.001
Study design				
Cross-sectional studies and case-control study	8	1.20 (0.99, 1.47)	32.0%	0.169
Cohort studies	3	0.79 (0.54, 1.17)	89.0%	<0.001
Altitude				
<3500 MASL	2	1.24 (0.78, 1.95)	25.0%	0.922
≥3500 MASL	9	1.00 (0.79, 1.26)	78.0%	<0.001
Quality assessment				
NOS/aNOS = 5	7	1.17 (0.97, 1.41)	23.0%	0.253
NOS/aNOS = 6-7	4	0.92 (0.62, 1.36)	87.0%	<0.001
Type of participant				
Mountaineer	7	1.17 (0.97, 1.41)	23.0%	0.253
Nonmountaineer	4	0.92 (0.62, 1.36)	87.0%	<0.001

AMS: acute mountain sickness; CI: confidence interval; MASL: meters above sea level; NOS: Newcastle-Ottawa Quality Assessment Scale; aNOS: adapted Newcastle-Ottawa Quality Assessment Scale; RR: relative risks. Relative risks were obtained using the DerSimonian and Laird random-effect model.

ID	Author	Smokers		Nonsmokers		Weight (%)	RR (95% CI)
		Events	Total	Events	Total		
(1)	Wu et al., 2012	71	182	102	200	16.4%	0.76 (0.61, 0.96)
(2)	Li et al., 2011	746	2242	450	1485	43.0%	1.11 (0.95, 1.29)
(3)	Wagner et al., 2008	25	51	352	835	6.8%	1.16 (0.87, 1.56)
(4)	You et al., 2012	36	138	83	176	12.3%	0.55 (0.40, 0.76)
(5)	Vinnikov et al., 2014	9	17	6	28	0.8%	2.47 (1.07, 5.72)
(6)	McDevitt	25	37	133	295	5.0%	1.50 (1.16, 1.94)
(7)	Mairer et al., 2009	12	61	58	370	2.8%	1.25 (0.72, 2.20)
(8)	Mairer et al., 2010 (Eastern Alps)	4	9	26	70	1.0%	1.20 (0.54, 2.64)
(9)	Mairer et al., 2010 (Western Alps)	3	13	26	70	1.4%	0.62 (0.22, 1.75)
(10)	Schneider et al., 2002 (Substudy 1)	21	72	99	368	5.5%	1.08 (0.73, 1.61)
(11)	Schneider et al., 2002 (Substudy 2)	15	56	106	331	5.2%	0.84 (0.53, 1.33)
Total (95% CI)						100.0%	*1.02 (0.83, 1.26)*
Total events		575	2878	1203	4228		



Heterogeneity: Cochran's Q = 37.43 ($P < 0.001$); $I^2 = 73\%$

Test for overall effect: $Z = 0.22$ ($P = 0.828$)

Figure 2: Forests plots of relative risks of AMS and smoking. AMS: acute mountain sickness; CI: confidence interval; RR: relative risks. The relative risks were obtained by random effect (DerSimonian and Laird).

than if the traveller climbed higher than 3500 MASL. This probably reflects comparison between climbers, who go to higher altitudes, and nonclimbers. Meta-analysis suggested that smoking was not significantly associated with AMS risk. The association was not significantly affected by study design, type of exposure or participants, altitude, study quality, or severity of AMS. However, we could not use the adjusted OR for the meta-analysis because most authors did not adjust for smoking in the original manuscripts. Therefore, these data were not available. However, evaluation of cigarettes per day might lend support for an association between exposure and disease [25]. Therefore, further investigation into the role of smoking in AMS risk is needed, with an emphasis on smoking duration and the number of cigarettes

Table 4: Results of sensitivity analyses for AMS risk by smoking status.

ID	Study omitted	Pooled RR (95% CI)	Heterogeneity I^2	Heterogeneity P
(1)	Wu et al., 2012	1.07 (0.85, 1.34)	70.0%	<0.001
(2)	Li et al., 2011	1.02 (0.78, 1.32)	76.0%	<0.001
(3)	Wagner et al., 2008	1.01 (0.80, 1.27)	73.0%	<0.001
(4)	You et al., 2012	1.10 (0.92, 1.32)	59.0%	0.002
(5)	Vinnikov et al., 2014	0.98 (0.80, 1.21)	73.0%	<0.001
(6)	McDevitt et al., 2014	0.97 (0.78, 1.19)	67.0%	<0.001
(7)	Mairer et al., 2009	1.01 (0.81, 1.26)	76.0%	<0.001
(8)	Mairer et al., 2010 (Eastern Alps)	1.02 (0.82, 1.27)	76.0%	<0.001
(9)	Mairer et al., 2010 (Western Alps)	1.04 (0.84, 1.29)	75.0%	<0.001
(10)	Schneider et al., 2001 (sub-study 1)	1.02 (0.81, 1.28)	76.0%	<0.001
(11)	Schneider et al., 2001 (sub-study 2)	1.04 (0.83, 1.31)	75.0%	<0.001

AMS: acute mountain sickness; CI: confidence interval; RR: relative risks. Relative risks were obtained using the DerSimonian and Laird random-effect model.

smoked. Heterogeneity is often a concern in a meta-analysis. Evidence of substantial heterogeneity across studies of the associations of smoking and AMS risk was observed in our meta-analysis, primarily in high-quality cohort studies, high altitudes, and mountaineer populations. Smoking and AMS definitions without sample size estimations differed in across studies, which affected prospective studies because the power to confirm the hypothesis was suboptimal. Moreover, the included studies were conducted in different countries and on different continents, and these populations likely have different smoking prevalence, lifestyle, prevention measures, and AMS incidence. Therefore, the characteristics of subjects and study design might have contributed to the observed heterogeneity. The subgroup analyses of cross-sectional or case-control studies, low altitudes, moderate quality observational studies, and mountaineers detected no significant heterogeneity ($P > 0.05$). These other studies likely did not estimate a formal sample size, but the feasibility to develop these study designs in a short period was demonstrated. The same authors developed some of them, and heterogeneity was almost absent.

4.2. Altitude. We ignored the specific ascent rate in each study; hence, we considered only the maximum altitude the participants reached. Low altitude was defined when the highest altitude reached was below 3500 MASL; moderate to high altitude occurred when the greatest altitude was equal to or higher than 3500 MASL. No significant reduction in AMS risk was associated with low or high altitude in smokers. Some authors found that smoking protected against AMS development [11, 14], whereas others found that smoking increased AMS development [12, 13] in different altitudes.

4.3. Mountaineers. The effect of the type of participants was based on the likely presence and absence of training in mountaineers and nonmountaineers, respectively. Most evaluated studies did not provide stratified data of AMS by smoking status or previous physical training (e.g., the number of nights spent above 3000 MASL or months before the ascent). Previous physical training could produce some impact on acclimatisation. Therefore, the decrease in AMS incidence could be quite similar to the smoking effect on acclimatisation. However, this effect was not demonstrated in the subgroup analyses because mountaineers frequently ascend to higher altitudes, and this group showed previous training and a low smoking prevalence. Mountaineers showed a low smoking prevalence (11.3%) in our subgroup analysis, and nonmountaineers exhibited a higher prevalence (55.5%) ($P < 0.001$). These findings could be due to a comparison between mountaineers, who go to higher altitudes, and nonmountaineers.

4.4. Limitations. First, the observed association may be masked by the lack of temporality because our analysis was primarily based on cross-sectional studies. These studies were developed in huts just prior to ascent. Therefore, the development of AMS that was described by the authors as prevalent episodes should likely be described as incident events. Smoking status was described at the time of AMS development, but smoking was obviously present before the ascent. Moreover, unmeasured or residual confounding is always a major concern in observational studies. The results of sensitivity and subgroup analyses showed robustness, and the relationship between AMS and smoking was not influenced by study design or quality, altitude or the type of participant or exposure. Therefore, the likelihood that our findings resulted from other unmeasured confounders cannot be excluded, and our meta-analysis suffers from heterogeneity and lack of studies that specifically looked at smoking and AMS, so more studies are needed. Second, we were unable to evaluate the dose–response effect of smoking on AMS development because it was not described in any study. Third, the AMS case definition was based on different diagnosis criteria or questionnaires. Headache is a cornerstone symptom for the diagnosis of AMS in Western countries; however, in China, it is not essential, and some language discrepancies between LLS and the Chinese Scoring System make difficult their direct comparison. Finally, one study defined AMS according to compression chamber use, so this study probably underestimated the mild AMS prevalence. Therefore, a misclassification of subjects was possible, and the relationship between smoking and AMS risk may be under- or overestimated. Finally, publication bias may be a problem because studies with null effects are less likely to be published than studies that provide statistically significant results. Egger's test and Begg's funnel plots detected no evidence of publication bias in the meta-analysis, but that estimation may not be sufficiently accurate because the number of included studies and population was relatively small.

5. Conclusions

In summary, the present meta-analysis of 11 observational studies indicated that smoking did not either reduce or increase the risk of AMS. However, many questions must be addressed. Further large-scale prospective studies, using a strict case definition of AMS and smokers and confounders, are warranted to validate our findings.

Conflicts of Interest

No financial conflicts of interest exist.

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Research Article

Prevalence and Association of Obesity with Self-Reported Comorbidity: A Cross-Sectional Study of 1321 Adult Participants in Lasbela, Balochistan

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Association of fatness with chronic metabolic diseases is a well-established fact, and a high prevalence of risk factors for these disorders has increasingly been reported in the third world. In order to incorporate any preventive strategies for such risk factors into clinical practice, decision-makers require objective evidence about the associated burden of disease. A cross-sectional study of 1321 adults from one of the districts of Balochistan, among the most economically challenged areas of Pakistan, was carried out for the measures of fatness and self-reported comorbidities. Body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) were measured and demographic information and self-reported comorbidities were documented. The prevalence of obesity was 4.8% (95% CI: [3.8, 6.1]) and 21.7% (95% CI: [19.5, 24.0]), as defined by the World Health Organization (WHO) international and Asia/Asia-Pacific BMI cut-offs, respectively. The proportion exhibiting comorbidity increased with increasing levels of fatness in a dose-response relationship (p value < .001). An interaction of weight status with gender was observed to produce a significantly ($p = .033$) higher comorbidity among overweight women (odds ratio (OR) = 6.1 [1.2, 31.7]) compared with overweight men (OR = 1.1 [0.48, 2.75], $p = .762$).

1. Introduction

Globally, the prevalence of obesity more than doubled between 1980 and 2014. Around 1.9 billion (39%) adults, 38% of men and 40% of women, have been reported to have weights above the normal range. Of these, over 600 million (13%) were found to be obese (11% of men and 15% of women) [1]. This obesity epidemic, previously thought to be a burden of affluent societies, has been noticed to have reached the low- and middle-income countries as a result of the epidemiologic transition [2–4].

Developing countries have been noted to be facing a dual burden of undernutrition and overnutrition simultaneously, exerting substantial strains on the already overburdened health systems [4]. The prevalence of overweight and obesity has increased severalfold in Asia, especially in South Asia [5], over the past few decades, with the extent varying between countries [6], although not very different from that in the United States [7]. Pakistan stands eighth among the 10 countries hosting half of the 693 million obese individuals in the world: USA, China, India, Russia, Brazil, Mexico, Egypt, Pakistan, Indonesia, and Germany [8].

Obesity is a major risk factor for a range of chronic disorders such as cardiovascular diseases (CVD), hypertension, type 2 diabetes mellitus (DM), hypercholesterolemia, osteoarthritis (OA), major depression [9], and certain cancers (CA) [8]. Globally, 23% of CVD, 44% of type 2 DM, and 7–41% of certain cancers are attributable to overweight and obesity, with a major share from developing countries [5].

Obesity has been found to be associated with at least as much morbidity as poverty, smoking, and alcoholism, despite receiving lesser attention in clinical practice and public health domains [10]. In Asia, there is a general paucity of research on obesity using metrics other than BMI, and even for BMI, the cut-off values used are not Asia-Pacific-specific as recommended by the WHO.

The plight of multiple comorbid states has been reported to afflict up to 50% of adult populations [11], with the estimates varying from 13% to 95% [12]. A palpable lack of research focus regarding the overall burden of this important health problem as well as the balance of inquiry regarding geographic and diagnostic entities has been highlighted, especially for the relatively less disadvantaged tiers of populations in the Eastern Mediterranean region [13].

The aim of this study was to determine the prevalence of obesity and its association with self-reported comorbidity by using different anthropometric measures: BMI (both WHO international and Asian cut-offs), waist circumference (WC), and waist-to-hip ratio (WHR). We also investigated whether the associations varied by gender among a representative sample of adults from the population of the Lasbela District, Balochistan.

2. Methods

2.1. Sample Size. Assuming a 15% prevalence of obesity in Pakistan [14], a sample size of 1225 individuals would estimate the true population proportion of obese persons with a 2% margin of error at 95% confidence level. Adding a 10% nonresponse rate, a sample size of 1347 was targeted.

2.2. Data Source. Data were collected using multistage stratified random sampling [15]. Out of a sampling frame of 30,000 households from 22 union councils treated as strata, a simple random sample of 270 households and 1321 individuals was selected after exclusion of nonresponders, with a number proportionate to the population from each union council. A list of households in each union council was obtained from the local census offices.

2.3. Data Collection. Data for all persons 18 years of age or older, excluding pregnant females, were collected. Face-to-face interviews were conducted by staff specially trained in the measurement process and filling the data collection instrument. The information gathered consisted of demographics (age, gender, education, monthly income, occupation, marital status, and smoking status) and self-reported physician-diagnosed comorbidity (type 2 DM, CVD, hypertension, hypercholesterolemia, OA, and CA). Anthropometric measurements including height, weight, WC, and hip circumference (HC) were taken, with standard operating procedures. Each measurement was taken three times in tandem and then the mean was calculated. BMI was calculated by dividing weight in kilograms (measured after removal of shoes and heavy outer clothing using a CAMRY weighing scale) by the square of height in meters (measured without shoes using a nonstretchable tape). WHR was calculated by dividing WC (measured by a nonstretchable tape at the level of the umbilicus) by hip circumference (measured at the widest point using the same tape) [9].

2.4. Operational Definitions

2.4.1. Comorbidity. Within the context of this study, comorbidity is defined as a self-report of a doctor's diagnosis or taking medication prescribed by a doctor for one or more of the following conditions: CVD (coronary heart disease or stroke), hypertension, hypercholesterolemia, type 2 DM, osteoarthritis, or cancer [9].

2.4.2. Obesity

Body mass index (BMI) based international cut-offs: underweight ($<18.5\,\mathrm{kg/m^2}$), normal weight (18.5–24.9 $\mathrm{kg/m^2}$), overweight (25.0–29.9 $\mathrm{kg/m^2}$), and obese ($\geq 30\,\mathrm{kg/m^2}$).

The World Health Organization (WHO) recommended cut-offs for Asia and Asia-Pacific region: underweight ($<18.5\,\mathrm{kg/m^2}$), normal weight (18.5–22.9 $\mathrm{kg/m^2}$), overweight (23.0–24.9 $\mathrm{kg/m^2}$), and obese ($\geq 25\,\mathrm{kg/m^2}$) [16].

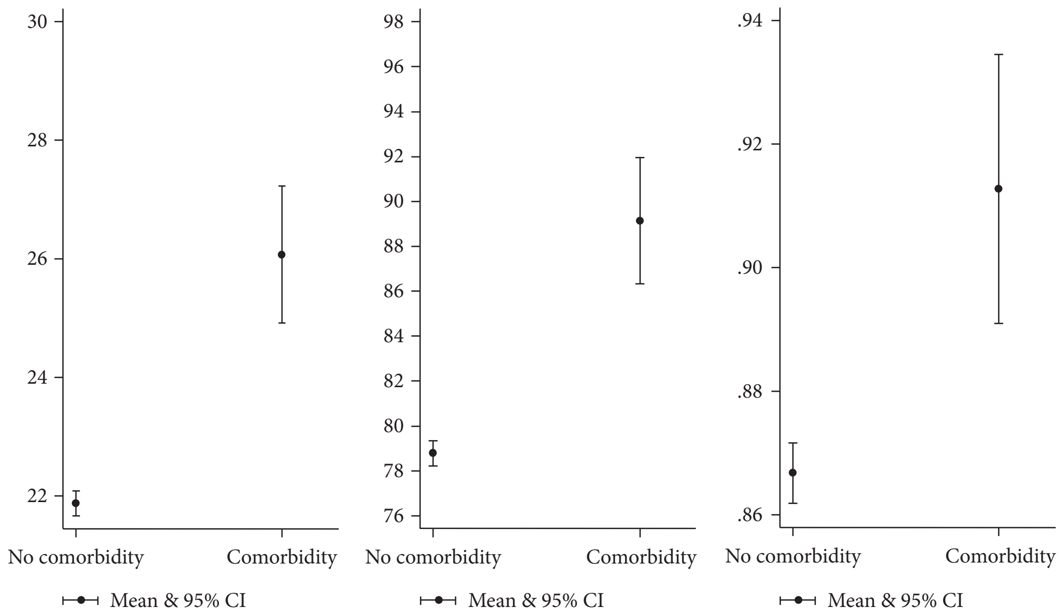
Waist circumference (WC) based cut-offs: normal weight (<94 cm), overweight (94–101.99 cm), and obese (≥102 cm) for men; normal weight (<80 cm), overweight (80–87.99 cm), and obese (≥88 cm) for women.

Waist-to-hip ratio (WHR) based cut-offs: normal weight (<0.90), overweight (0.90–0.99), and obese (≥1) for men; normal weight (<0.80), overweight (0.80–0.84), and obese (≥0.85) for women [17].

2.5. Ethical Considerations. This study was conducted after approval from the Ethical Board of the Khyber Medical University, Peshawar (KMU-EB). Consent was taken from the participants on a consent form written in English and Urdu and after explaining to them the elements of the informed consent, their autonomy, confidentiality, right to withdraw at any time they felt uncomfortable, measurement process, and the whole purpose of the study.

3. Statistical Analysis

Chi-square (χ^2) tests are used for cross-tabulation analyses. Associations among dichotomized anthropometric measures and comorbidity are assessed by means of univariate and multivariate logistic regression models. Odds ratios (OR) with 95% confidence intervals (CI) are reported and receiver operating characteristic curves presented for these analyses. In the multivariate model, possible confounding factors, that is, gender, age, marital status, education, monthly income, occupation/work status, and smoking status, are adjusted for. Significance of interactions in logistic regression is assessed using Wald's test. Stata version 12.1 (StataCorp, College Station, Texas) has been used to carry out analyses. All tests of statistical significance are two-tailed with an alpha of .05.



(a) Mean BMI (kg/m^2) (b) Mean WC (cm) (c) Mean WHR

Figure 1: Means of anthropometric measurements *(overall)* with having self-reported comorbidity.

Cohen's d and r-squared are reported as measures of effect size for t-tests, Cramér's V for chi-square tests, r for two-sample tests of proportions, and OR with CI and area under the receiver operating characteristic curve for logistic regression analyses.

4. Results

Complete data were available for 1321 persons. With 26 nonresponders, the response rate was 98%. Compared with the participating family members, the nonresponders did not differ in any significant way.

Of the 1321 participants, 659 (49.89%) were males. Mean (M) age of the participants was 32.21 years, with a standard deviation (SD) of 12.83 years.

Mean BMI, WC, and WHR were 22.22 kg/m^2 (SD: 4.14 kg/m^2), 79.61 cm (SD: 10.86 cm), and 0.87 (SD: 0.04), respectively.

Mean BMI, WC, and WHR were all significantly different between those who had one or more comorbid conditions and those without any comorbidity ($t(1319) = -10.3915$, -9.7439, and -5.0954; all p values < .001; $d = 0.72$, 0.99, and 0.52; $r^2 = 0.08$, 0.07, and 0.02, resp.) (Figure 1).

Among men, mean BMI, WC, and WHR were all significantly different between those who had one or more comorbid conditions and those without any comorbidity ($t(1319) = -4.5358$, -7.9175, and -4.3972; all p values < .001; $d = 0.69$, 1.2, and 0.67; $r^2 = 0.03$, 0.09, and 0.03, resp.) (Figure 2).

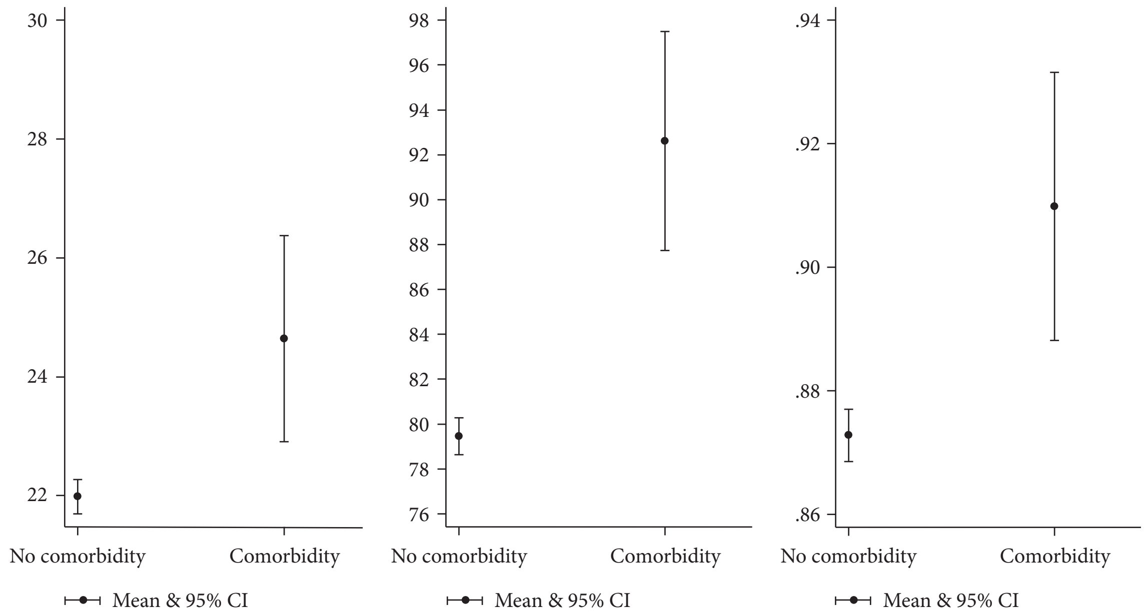
Among women, mean BMI, WC, and WHR were all significantly different between those who had one or more comorbid conditions and those without any comorbidity ($t(1319) = -9.7182$, -6.1836, and -2.9383; p values < .001, <.001, and .003; $d = 1.3$, 0.083, and 0.4; $r^2 = 0.12$, 0.06, and 0.01, resp.) (Figure 3).

While WC differed significantly between men (M = 80.4 cm, SD = 11.4 cm) and women (M = 78.8 cm, SD = 10.3 cm) ($t(1319) = 2.5360$, $p = .011$, $d = .14$, $r^2 = .005$), BMI and WHR did not show such difference (p values: .667 and .901, resp.).

The prevalence of obesity was 4.84% (95% CI: [3.8, 6.1]) by international cut-offs and 21.73% [19.5, 24.0] on Asian cut-offs of BMI. On WC measurement and WHR measurement, 10.9% [9.3, 12.7] and 44.4% [41.7, 47.2] were obese, respectively. An obese individual was more likely to be ≥45 years of age (two-sample test of proportions: $z = -6.2641$, $p < .001$, $r = -0.08$), married ($z = -3.5053$, $p < .001$, $r = -0.1$), uneducated ($z = 2.6437$, $p = .008$, $r = 0.07$), and a smoker ($z = -2.9285$, $p = .003$, $r = -0.08$). A person with one or more comorbidities, compared to those without one, was more likely to be female ($z = -4.7976$, $p < .001$, $r = -.13$), forty-five years of age or older ($z = -15.1801$, $p < .001$, $r = -.42$), obese ($z = -8.3415$, $p < .001$, $r = -.23$), uneducated ($z = 6.1805$, $p < .001$, $r = -.17$), and current or ex-smoker ($z = -3.0239$, $p = .0025$, $r = -.08$).

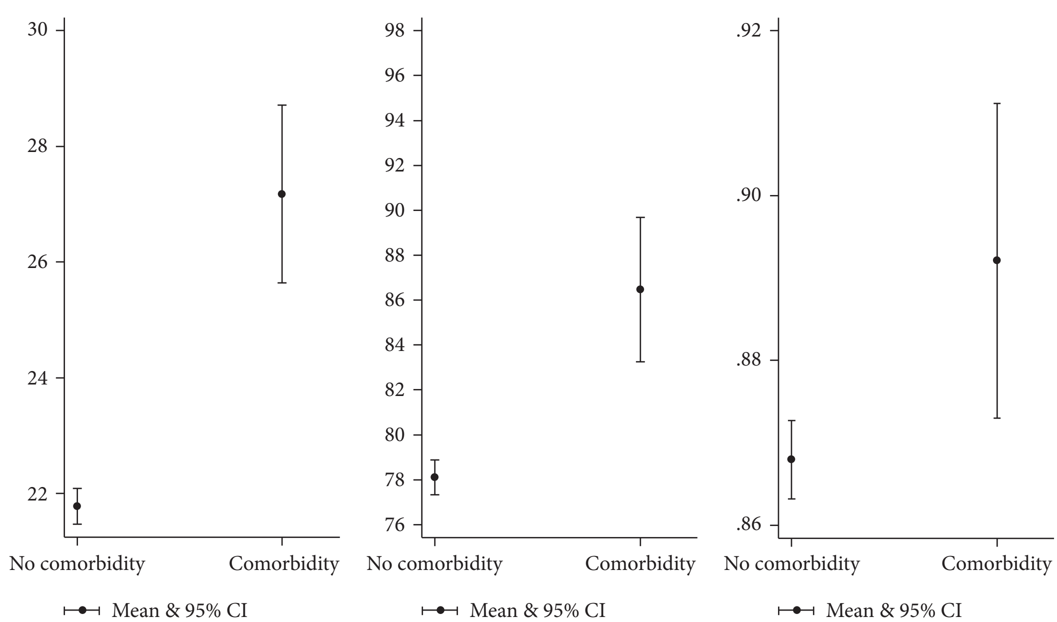
Overall, 8.02% [6.6–9.6%] of the participants reported themselves as having one or more comorbidities, among whom 43.4% [33.8, 53.4] were men and 56.6% [46.6, 66.2] were women. The difference in proportion of the two genders among those who reported comorbidity was statistically not significant (two-sample test of proportions: $z = -1.9219$, $p = .06$, $r = -0.13$).

The prevalence of various comorbid states, with 95% confidence intervals, was as follows: cardiovascular disease, 1.7% [1.0, 2.5]; hypertension, 5.3% [4.2, 6.6]; type 2 diabetes mellitus, 2.2% [1.5, 3.1]; hypercholesterolemia,



(a) Mean BMI (kg/m^2) (b) Mean WC (cm) (c) Mean WHR

Figure 2: Means of anthropometric measurements *(men)* with having self-reported comorbidity.



(a) Mean BMI (kg/m^2) (b) Mean WC (cm) (c) Mean WHR

Figure 3: Means of anthropometric measurements *(women)* with having self-reported comorbidity.

0.9% [0.5, 1.6]; and osteoarthritis, 4.2% [3.2, 5.4]. None of the participants reported any malignancy.

All of the following variables were significantly associated with self-reported comorbidity: obesity, using both international and Asian cut-offs for BMI (χ^2 (3, N: 1321) = 99.16 and 72.26, both p values < .001, V = 0.27 and .23, resp.), obesity as defined by WC (χ^2 (2, N: 1321) = 113.70, p < .001, V = 0.29), obesity as defined by WHR (χ^2 (2, N: 1321) = 21.32, p < .001, V = 0.13), age (χ^2 (3, N: 1321) = 255.18, p < .001, V = 0.44), marital status (χ^2 (1, N: 1321) = 21.48, p < .001, V = 0.13), educational status (χ^2 (1, N: 1321) = 38.22, p < .001, V = −0.17), and smoking status (χ^2 (2, N: 1321) = 9.42, p = .009, V = 0.08) (Table 1).

In overall multiple logistic regression analysis, after adjusting for potential confounders, that is, gender, age, marital status, education, monthly income, occupation/work

Table 1: Characteristics of the participants by self-reported comorbidity.

	Self-reported comorbidity		p value
	No $N = 1215$ (91.98%) N (%)	Yes $N = 106$ (8.02%) N (%)	
Gender			
Men	613 (93.02)	46 (6.98)	0.163
Women	602 (90.94)	60 (9.06)	
Age (years)			
18–30	758 (98.06)	15 (1.94)	<0.001
31–44	299 (95.22)	15 (4.78)	
45–59	112 (73.68)	40 (26.32)	
≥60	46 (56.10)	36 (43.90)	
BMI category (international cut-offs)			
Underweight	226 (96.58)	8 (3.42)	<0.001
Normal weight	759 (94.88)	41 (5.12)	
Overweight	189 (84.75)	34 (15.25)	
Obesity	41 (64.06)	23 (35.94)	
BMI category (Asian cut-offs)			
Underweight	226 (96.58)	8 (3.42)	<0.001
Normal weight	572 (95.65)	26 (4.35)	
Overweight	187 (92.57)	15 (7.43)	
Obesity	230 (80.14)	57 (19.86)	
WC category			
Normal weight	903 (95.35)	44 (4.65)	<0.001
Overweight	212 (92.17)	18 (7.83)	
Obesity	100 (69.44)	44 (30.56)	
WHR category			
Normal weight	587 (95.14)	30 (4.86)	<0.001
Overweight	98 (83.76)	19 (16.24)	
Obesity	530 (90.29)	57 (9.71)	
Marital status			
Unmarried	483 (96.41)	18 (3.59)	<0.001
Married	732 (89.27)	88 (10.73)	
Education			
Uneducated	571 (87.31)	83 (12.69)	<0.001
Educated (≥5 years)	644 (96.55)	23 (3.45)	
Monthly income (PKR)			
Low income (≤8500)	280 (92.11)	24 (7.89)	0.925
Middle income (8501–103900)	935 (91.94)	82 (8.06)	
Occupation/work status			
Unemployed	752 (91.93)	66 (8.07)	0.990
Employed (skilled)	236 (92.19)	20 (7.81)	
Labor (unskilled)	227 (91.90)	20 (8.10)	
Smoking status			
Never smoked	938 (93.24)	68 (6.76)	0.009
Ex-smoker	85 (86.73)	13 (13.27)	
Current smoker	192 (88.48)	25 (11.52)	

Comorbidity is the presence of one or more of the following conditions: type 2 DM, hypertension, CVD, hypercholesterolemia, OA, and CA. The reported p values are for chi-square tests of independence for categorical data.

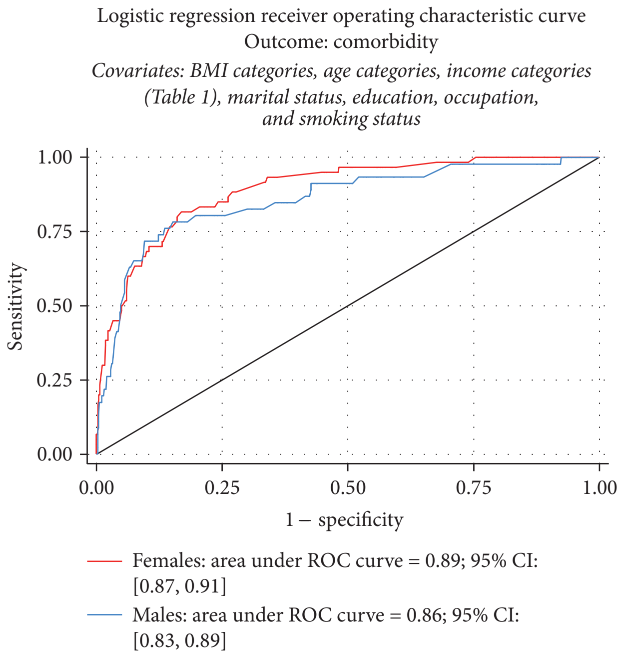


Figure 4: Areas under the ROC curve from logistic regression for males and females.

status, and smoking status, the association between obesity (as defined by international and Asia-specific cut-off values of BMI) and comorbidity was significant (odds ratios (OR) = 5.75 [2.84, 11.64] and 2.87 [1.66, 4.97], resp., both p values $< .001$). Overweight was significantly associated with comorbidity only as defined by international cut-offs only (OR = 1.89 [1.10, 3.26], $p = 0.021$).

Association between obesity as defined by waist circumference and comorbidity was significant (OR = 3.76 [2.06, 6.85], $p < .001$). However, obesity as defined by waist-to-hip ratio did not show a significant association with comorbidity (OR = 1.72 [.63, 4.72], $p = .292$) (Table 2).

In gender-specific multiple logistic regression analysis, the association between obesity and comorbidity for men was significant for international BMI cut-offs (OR = 8.49 [2.50, 28.81], $p = .001$) but not for Asian cut-offs (OR = 1.96 [.86, 4.48], $p = .109$); for women, the association was significant for both cut-offs (OR = 5.19 [2.03, 13.26], $p = .001$; OR = 3.73 [1.68, 8.29], $p = .001$, resp.) (Figure 4).

The international cut-offs defined overweight was significantly associated with the outcome of comorbidity for women only (OR = 2.64 [1.23, 5.67], $p = .013$), an association not observed in men or with the Asian cut-offs of BMI for women.

Obesity as defined by waist circumference was significantly associated with comorbidity for men as well as women (OR = 6.38 [2.24, 18.19], $p = 0.001$; OR = 3.38 [1.49, 7.64], $p = .004$, resp.). As defined by waist-to-hip ratio, obesity did not show significant association for either sex.

The overweight category by both cut-offs for BMI showed an interaction with gender to produce significant association (OR: 6.05 [1.16, 31.74], $p = .033$) with the outcome of comorbidity for women but not men (OR = 1.14456 [0.48, 2.75], $p = .762$).

There was a significant linear trend of increasing comorbidities with progressively increasing weight categories, both by international and by Asia/Asia-Pacific cut-offs (Cuzick's tests for linear trend: $z = 8.83$ and 7.73, resp., p values $< .001$).

5. Discussion

Worldwide, obesity has been reported to incur a twofold increase in the risk of diabetes, hypertension, heart failure, ischemic stroke, ischemic heart disease, and osteoarthritis [18–22]. Our study has found a significant dose-response relationship between increasing comorbidities and increasing weight.

The association has important implications for public health planning and management as health effects of obesity at individual and community levels manifest themselves through these comorbid states, which we have shown to be increasing in direct proportion with increasing weight.

Thirty-seven percent [34.4, 39.7] of the participants in this study were either overweight (15.3% [13.4, 17.3]) or obese (21.7% [19.5, 24.0]), according to the recommended BMI cut-offs for Asian populations. Twenty percent [15.40, 24.95] of the obese individuals had one or more comorbid conditions.

Our results show a significantly higher prevalence of obesity among those who were 45 years of age or older, married, uneducated, and smokers. Such associations have been reported by various studies across the world including Asia and South Asia [23].

We have found the prevalence of obesity to be 21.7% [19.5, 24.0] and that of underweight to be 17.8% [15.7, 19.9], highlighting the simultaneous burden of the two extremes [4]. The prevalence of underweight that we found is higher than that reported in Pakistan previously (12.3%) [14], probably a reflection of the locale specific economic realities.

Our finding of a significant association of obesity with comorbidities has been reported previously [24] but the levels of different anthropometric measurements at which the participants reported comorbidity in our study were lesser compared to those reported in USA and Europe, probably because Asians are known to carry greater body fat content for a given BMI [25].

This study has shown that the association between BMI (international cut-offs) and self-reported comorbidity differs by the gender; while only obese, not overweight, men were significantly more likely to report comorbidity, both overweight and obese women showed such association. Overweight men, compared with overweight women, have been found to report relatively better quality of life, better psychological health, and more happiness [26–28].

5.1. Strengths and Limitations of the Study. The sampling technique for this study was robust enough to ensure representativeness of the sample and external validity. Different anthropometric measures of obesity as well as various cut-off

Table 2: Overall and gender-wise multivariate logistic regression analysis of the participants' characteristics (both BMI international and Asian cut-offs, WC and WHR categories) associated with having self-reported comorbidity.

	Overall Multivariate analysis		Multivariate analysis Men		Multivariate analysis Women	
	Odds ratio [95% CI]	p value	Odds ratio [95% CI]	p value	Odds ratio [95% CI]	p value
BMI category (international cut-off)						
Underweight	0.99 [0.42, 2.32]	0.978	1.12 [0.37, 3.45]	0.836	0.75 [0.19, 2.98]	0.689
Normal weight	1	—	1	—	1	—
Overweight	1.89 [1.10, 3.26]	0.021	1.14 [0.48, 2.75]	0.762	2.64 [1.23, 5.67]	0.013
Obesity	5.75 [2.84, 11.64]	<0.001	8.49 [2.50, 28.81]	0.001	5.19[2.03, 13.25]	0.001
BMI category (Asian cut-off)						
Underweight	1.10 [0.45, 2.66]	0.835	1.16 [0.36, 3.66]	0.805	0.88 [0.21, 3.67]	0.863
Normal weight	1	—	1	—	1	—
Overweight	1.38 [0.67, 2.84]	0.382	1.19 [0.44, 3.21]	0.728	1.52 [0.51, 4.55]	0.453
Obesity	2.87 [1.66, 4.97]	<0.001	1.96 [0.86, 4.48]	0.109	3.73 [1.68, 8.29]	0.001
WC category						
Normal weight	1	—	1	—	1	—
Overweight	1.20 [0.62, 2.33]	0.588	0.95 [0.27, 3.31]	0.933	1.20 [0.51, 2.81]	0.669
Obesity	3.75 [2.06, 6.85]	<0.001	6.38 [2.24, 18.19]	0.001	3.37 [1.49, 7.64]	0.004
WHR category						
Normal weight	1	—	1	—	1	—
Overweight	1.95 [0.84, 4.51]	0.118	2.15 [0.81, 5.70]	0.126	1.96 [0.06, 68.90]	0.710
Obesity	1.72 [0.63, 4.72]	0.292	3.93 [0.99, 15.58]	0.052	1.06 [0.33, 33.70]	0.975

CI: confidence interval, adjusted by gender, age, marital status, education, monthly income, occupation/work status, and smoking status.

values were used to provide a broader range of assessment for measures of fatness. Anthropometric measurements were done by trained staff rather than relying on self-reported obesity.

Other than being subject to various biases known to beset cross-sectional studies, causality cannot be inferred from the reported associations from this study.

6. Conclusion

Comorbidities increase with increasing weight in a dose-response relationship. With the changing social structure and lifestyles in the area, the problem can only get worse with time if not addressed by healthcare planners.

7. Recommendations

In order to reduce the healthcare costs, effective preventive strategies have to be put in place at various tiers of healthcare delivery systems.

Additional research with longitudinal design is needed to define the temporal characteristics of association between obesity and its associated comorbidities.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Research Article

Health Status and the Demand for Healthcare among the Elderly in the Rural Quoc-Oai District of Hanoi in Vietnam

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Background. Vietnam is experiencing an unprecedented demographic transition. Its proportion of elderly people is growing rapidly. *Objective*. This study explored the health status and health-related quality of life (HRQoL) of rural elderly Vietnamese and assessed their needs for healthcare services. *Design*. This study used a survey with stratified proportion sampling and quota assignment. In 2016, data was collected from 713 people in the rural Quoc-Oai district of Hanoi aged 60 or older. *Results*. The mean age of the respondents was 70.9. Both self-rated health status and functional status decreased with age. Women reported more functional limitations than men. Musculoskeletal disorders were the most frequently reported chronic diseases, followed by hypertension, gastrointestinal diseases, and cardiovascular diseases. Age, self-rated health status, BMIs, and the number of noncommunicable diseases (NCDs) were found to be significant determinants of HRQoL, after controlling for socioeconomic effects. More than half the respondents requested more healthcare information, particularly on disease management. *Conclusions*. Vietnam's healthcare system is being challenged to make health services easily accessible and meet the growing needs for chronic illness management, risk reduction, promoting healthy lifestyles, and improving the aging population's quality of life.

1. Introduction

The world's population is aging, and this trend is also evident in Vietnam, where the proportion of people over 60 years of age has increased rapidly in recent decades, from 6.7% in 1979 to 10% in 2013. Further influencing this trend is confirmation that life expectancy at birth increased from 66 years in 1990 to 76 years by 2012 [1]. Meanwhile, epidemiological evidence has shown that even in developing countries the most prevalent diseases are no longer communicable diseases, but rather noncommunicable diseases (NCDs). The World Health Organization's 2014 NCD Country Profile for Vietnam estimated that NCDs account for 73% of all deaths [2]. Mean systolic blood pressure readings have been increasing since 1980, and mean total cholesterol levels have also been increasing since 1996. Stroke and ischemic heart disease were the leading causes of death in 2012 [2].

These data highlight elderly people's need to adopt lifestyle modifications for their health. However, lifestyle changes are not made easily. Systematic education, motivation, and continuous monitoring by health professionals might be very helpful for encouraging lifestyle changes. In addition, functional status and health status are both highly related to the quality of life, and especially so for the elderly [3]. In one study, almost ten percent of the respondents reported a need for some help conducting activities of daily living (ADL), while over two-thirds of the elderly in rural Vietnam indicated that they needed instrumental or intellectual ADL support [4].

With rapid industrialization, young people moved to urban areas for employment, and, over time, the family structure in rural areas has changed significantly. In 1998, the proportion of families comprised only of elderly spouses was 12.7%, and the proportion of elderly people aged 60 and over living alone was 4.93%. However, these proportions increased to 21.47% and 6.14%, respectively, in 2008 [5]. The combined percentage of elderly people who live on their own as couples and those who live alone continues to increase over time. In 2004 and 2005, L. Nguyen and T. H. Nguyen (2010) analyzed the secondary data of 979 elderly participants from five provinces in Vietnam (Quang Nam, Ho chi minh City, Thanh Hoa, Son La, and Kon Tum). Among 938 responders who chose home-based care when suffering from illness, 74.2% (696) of participants received care from their children, 22% (206) provided self-care, and 2.1% (20) received care from friends or others. Only 0.5% (5) of the participants hired a housemaid to take care for them. These numbers may increase or differ from the current situation, because of economic development, industrialization, and urbanization within Vietnam [6].

While elderly people in urban areas can benefit directly from facilities for the elderly [7], more than 70% of Vietnamese seniors live in rural areas, where limited financial resources are available [8]. The elderly who lived in rural areas were earlier cared for by their families; however, they can no longer rely solely on their families, and other sources of support should be proposed. The model of caring for elderly people within the community differed across different geographical regions within Vietnam [9]. According to one report, every elderly person suffers 2.69 diseases on average, and most of the elderly living in rural areas have poorer health status than their counterparts in urban areas [10]. It is evident that better planning is required to provide the aging populations in rural communities with the healthcare services they need.

To date, studies on the health status of elderly populations in Vietnam's rural areas have been very limited. Conducting these studies requires that the targeted population's functional status (ADL) and health-related quality of life (HRQoL) be evaluated and the factors that influence these measures be identified. Furthermore, their needs for healthcare services should be assessed, and strategies and policies for improving their health should be developed.

This study of elderly people in Vietnam's rural areas has two main objectives. The first is to explore this population's health status and HRQoL and to confirm the significant determinants. The second objective is to assess their needs for healthcare services.

2. Methods

2.1. Study Setting. This study was conducted in 2016 as part of a joint cohort study for a Health System Strengthening project led by collaborators from two universities in Vietnam and one in Korea. The project team selected the Quoc-Oai district of Hanoi—located 30 km from Western Hanoi—as the research area and conducted a community-based survey to generate baseline data. The area is divided into two strata, namely, lowland and mountainous areas. All clusters and corresponding population numbers were listed using a probability-proportional-to-size (PPS) technique [11] that is a widely used and recommended method for obtaining a representative national sample. A stratified multistage cluster sampling technique was used to identify households for this study. Based on a three-stage cluster sampling strategy, 2,400 households were randomly selected from 30 clusters (villages), which in turn had been randomly selected from 2 strata: lowlands and mountains. One person aged between 15 and 60 years was randomly selected from each household, and if there was more than one person over 60 living in a household, another person aged over 60 years was randomly sampled.

2.2. Sampling and Sample Size. The sample size selected for this survey was based on the formula suggested by the WHO [12], and a proportion of each population and the national figures estimated by Ho chi minh Medical University/WHO research. Based on this calculation, a sample size of approximately 1,100 people was required. In most prevalence surveys, a design effect of 1.5~2 is reasonable [13], so in this study the design effect of 2 was applied. Based on an expected nonresponse rate of about 10%, the final sample size was estimated to be 2,400 households.

The number of households that responded to the survey was 2,399, and the response rate was 99.9%. Individual interviewees were chosen using the Kish Method [14], and, in each selected household, the data collector interviewed the head of the household using the household questionnaire, and two household members using the questionnaire designed for individuals (one individual between 15 and 59 years of age, and one individual 60 years of age or older). The total number of individuals who responded to the survey was 3,070, and 824 individuals who were 60 years of age or older were selected to be study participants. Responses with incomplete data were removed, and the remaining 713 respondents were included in the final analysis. The sampling procedure is illustrated in Figure 1.

2.3. Data Collection. Face-to-face interviews were conducted with participants using structured questionnaires. The questionnaires were divided into sections for households and individuals. After the survey had been completed, the data collected from the two surveys were consolidated. Double data-entry using Epidata 3.1 was performed, to evaluate inconsistent values for any variables. To ensure the study's accuracy, any responses with missing or irrelevant values were deleted.

2.4. Variable Measurements and Instruments. We used age, gender, ethnicity, location, marital status, educational level, religion, working status, and household size as demographic variables. Self-rated health status was measured using a 5-point Likert scale, which was reclassified into three categories: good, normal, and bad. BMIs were calculated using self-reported heights and weights and categorized on the basis of Asian-specific BMI cut-offs [15]. Chronic disease prevalence was measured with a multiple-choice questionnaire that asked the following question: "In the past 12 months, have you been diagnosed by a doctor with one or more of the following chronic diseases?"

Social capital encompasses different characteristics, such as social networks, social participation, social support, social

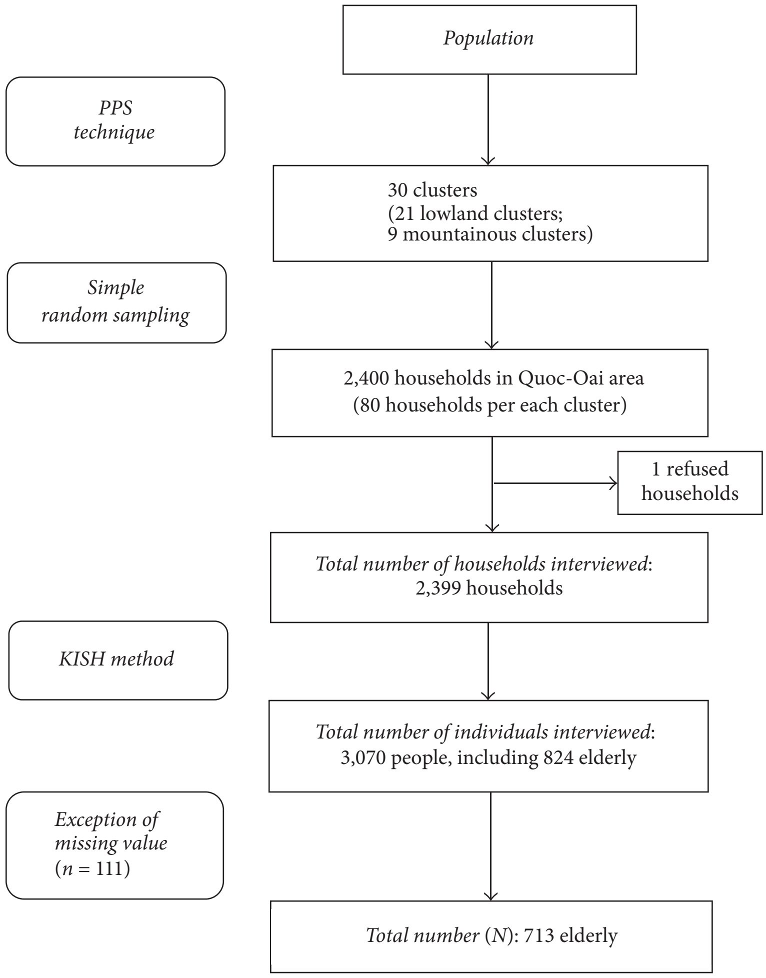

Figure 1: Sampling and data collection process.

cohesion, attitudes, and trust [16]. For this study, social capital was measured using an instrument developed in 2012 [17]. It consists of two domains: the first evaluates whether there is a relationship based on general trust or support between neighbors in everyday life, and the second asks whether there is a relationship based on trust in emergency situations. The first domain asks four questions with regard to general situations: they relate to a "willingness to help each other," the "perceived sense of living in a close-knit village," the "perceived level of a neighbor's trust," and "how much neighbors can work together." Respondents chose from one of five levels to indicate their level of agreement with these statements. The second domain consisted of four questions related to individuals in urgent need of help: they included "the possibility of receiving help from one's neighbor," "willingness to help," "the number of people who give sincere advice," and "the number of people from whom you can borrow money." The possible responses again consisted of four levels: four was the highest, and one was the lowest. Each score for the second domain was recalculated with a weighted value that changed it to its original score by 1.25.

The participants' functioning assessment was measured using a modified version of a generic assessment instrument for health and disability developed as part of a WHO Disability Assessment Schedule (WHODAS) [18]. This instrument consists of ten items asking questions about five domains: mobility, self-care, getting along, life activities, participation, and cognition. The higher one's score on the functioning assessment, the more limited the individual's physical activity level.

The Vietnamese version of the EQ-5D-3L questionnaire [19] was used to measure the health-related quality of life (HRQoL) of the elderly in rural areas. This questionnaire is comprised five dimensions, namely, mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Responses permitted for each dimension had three levels: no problems, some problems, and extreme problems. Even though the Vietnamese version of EQ-5D-3L was used, because it lacks the preference value set developed for Vietnam, the time trade-off valuation set from South Korea [15] was used in this study. The EQ-5D-3L index ranged from −0.171 to 1, and higher values indicated a better health-related quality of life.

Participants' needs for health information and home healthcare services were confirmed during interviews conducted using open-ended questions. Participants who responded by saying that they needed information with regard to their health status described what types of health information they wanted to receive. If they had any needs for home healthcare services—including rehabilitation—participants were asked to describe the health problems for which would they like to receive services. Interviewers summarized participants' answers and coded the responses using short words.

2.5. Data Analysis. SPSS Statistics 23 software was used for the statistical analysis. Descriptive statistical analyses were used to describe the socioeconomic characteristics, health status, prevalence of NCDs, social capital, functioning assessment, and health-related quality of life. Student's t-test and a one-way ANOVA were used to compare the differences between these characteristics in a functioning assessment and the HRQoL. For the post hoc test, Fisher's least significant difference (LSD) was applied. Multiple regression analysis was performed to detect the effects of factors on the HRQoL index. The significance level was set at $p < 0.05$.

The responses to open-ended questions for healthcare needs were analyzed using NVivo 11 software. The responses most frequently in all the subjective texts were selected and a weighted percentage was calculated, after which the authors created domains and categorized the texts into these domains.

2.6. Ethical Considerations. The Institutional Review Board of the Hanoi School of Public Health approved this study in 2016. After they had been informed of the purpose of the study and their rights, informed consent was obtained from all participants. They were told that they could refuse to participate, or choose to withdraw from an interview, at any time. Confidentiality was assured, by coding participants' responses.

3. Results

3.1. Demographic Characteristics. An overview of the distribution of study participants is provided in Table 1. The average age of study participants was 70.9, and the majority of them were between 60 and 69 years of age (52.9%). Of the 713 participants, 58.6% were women. Participants' ethnicity was primarily Kinh (81.3%), which is the largest ethnic group in Vietnam [20], and most of the participants lived in plain areas (77.8%). More than half the participants were married or reunited (58.5%), and the next-largest group was widowed (37.2%). In terms of their education levels, more than one-third had not completed primary school (34.6%), and 28.5% and 25.5%, respectively, had completed primary school and secondary school. Most participants had no religion (98.2%); those who were working among the participants (76.2%) were three times more than those who did not work (23.8%). The proportion of people living in the middle to the poorest households was higher than those in the richer or richest wealth quintiles. The percentage of those with health insurance was 72.5%.

Table 1: Demographic characteristics of the elderly (N = 713).

Variables	N	%
Age	(Mean ± SD)	(70.9 ± 8.81)
60 s	377	52.9
70 s	194	27.2
Over 80	142	19.9
Gender		
Male	295	41.4
Female	418	58.6
Ethnicity		
Kinh	580	81.3
Non-Kinh	133	18.7
Location		
Plain	555	77.8
Mountain	158	22.2
Marital status		
Married/reunion	417	58.5
Single/divorced/separated	31	4.3
Widowed	265	37.2
Education		
Under primary	247	34.6
Primary	203	28.5
Secondary	182	25.5
High school and higher	81	11.4
Religion		
Yes	13	1.8
No	700	98.2
Working status		
Unemployed & retired	170	23.8
Still working	543	76.2
Household size	(Mean ± SD)	(4.64 ± 2.08)
1-2 people	152	21.3
3-4 people	148	20.8
5-6 people	290	40.7
Over 7 people	123	17.3
Wealth quintile		
Richest	134	18.8
Richer	131	18.4
Middle	157	22.0
Poorer	152	21.3
Poorest	139	19.5
Health insurance		
Yes	517	72.5
No	196	27.5

3.2. Health Status and Chronic Disease Prevalence. Self-rated health status, body mass indexes (BMIs), and the prevalence of a chronic disease diagnosis by a doctor within 12 months are summarized in Table 2. The mean score of the self-rated health status was 58.4 (it ranged from 2 to 100) and tended to decrease with aging. Participants' average BMI scores were 19.9. Most of the participants (66.9%) were categorized within the "normal range" according to current WHO BMI cut-off points [21], but 16.3% of participants were mildly underweight (17.0–18.49 kg/m^2), 5.0%

Table 2: Health status and chronic disease prevalence of sample ($N = 713$).

Variables	60 s		70 s		Over 80		Total	
	n	%	n	%	n	%	n	%
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Self-rated health status								
Good	89	23.6	20	10.3	11	7.7	120	16.8
Normal	212	56.2	115	59.3	70	49.3	398	55.7
Bad	76	20.2	59	30.4	61	43.0	196	27.5
BMI	20.6	2.57	19.4	2.63	18.9	2.78	19.9	2.72
Severely underweight	17	4.5	13	6.7	26	18.3	56	7.9
Moderately underweight	11	2.9	19	9.8	6	4.2	36	5.0
Mildly underweight	46	12.2	40	20.6	30	21.1	116	16.3
Normal	282	74.8	118	60.8	77	54.2	477	66.9
Overweight	21	5.6	4	2.1	3	2.1	28	3.9
Recent smoker* ($n = 192$)								
Yes	71	53.0	13	34.2	4	20.0	88	45.8
Drinks in a month† ($n = 198$)								
Yes	111	79.3	22	64.7	12	50.0	145	73.2
Social capital								
Trust in daily life	4.17	0.497	4.17	0.465	4.19	0.507	4.17	0.490
Trust in urgent need	3.04	0.631	2.98	0.605	2.94	0.651	3.00	0.628
Total	3.54	0.496	3.51	0.478	3.49	0.473	3.52	0.487
Diagnosed chronic disease								
Hypertension	102	27.1	69	35.6	54	38.0	225	31.6
Diabetes	14	3.7	7	3.6	5	3.5	26	3.6
Cancer	1	0.3	2	1.0	1	0.7	4	0.6
Neuropsychiatric diseases	16	4.2	5	2.6	6	4.2	27	3.8
Cardiovascular diseases	32	8.5	14	7.2	10	7.0	56	7.9
Respiratory diseases	20	5.3	11	5.7	14	9.9	45	6.3
Asthma/COPD	19	5.0	10	5.2	9	6.3	38	5.3
Liver-related diseases	23	6.1	5	2.6	1	0.7	29	4.1
Kidney-related diseases	29	7.7	10	5.2	5	3.5	44	6.2
Gastrointestinal diseases	82	21.8	28	14.4	13	9.2	123	17.3
Musculoskeletal diseases	180	47.7	103	53.1	79	55.6	362	50.8
Movement impaired	11	2.9	3	1.5	4	2.8	18	2.5
Others	46	12.2	31	16.0	19	13.4	96	13.5

*The person who smokes at the present. †The person who has used alcohol beverages in the last month.

were moderately underweight (16.0–16.9 kg/m^2), and 7.9% of participants were severely underweight (<16 kg/m^2). The total mean score for social capital in this study was 3.52 (0.487) on a 5-point scale. The average score for the first domain (trust in daily life), which was asking about one's generalized trust in everyday life, was 4.17 (0.490). The other domain, which asked questions concerning how one felt about neighbors' attitudes toward helping them when they were in an emergency situation, scored 3.00 (0.628). There are no statistically significant relationships between social capital and other variables such as age, gender, and wealth quintile. Musculoskeletal disorders were the most frequently reported chronic disease among all age groups (50.8%), followed by hypertension (31.6%), gastrointestinal diseases (17.3%), and cardiovascular diseases (7.9%). Very few cases of cancer or diabetes were reported.

3.3. Functional Status. The distribution of participants on the basis of the functional status of different groups is presented in Table 3. Functioning assessment scores were significantly different between gender and age groups, and the number of NCDs was significantly associated with functional status. Participants with more than three NCDs scored lowest in terms of their functioning status.

3.4. Health-Related Quality of Life. The mean indices of the health-related quality of life (HRQoL) as measured by EQ-5D-3L are presented in Table 4. The HRQoL decreased significantly with age. Men and Non-Kinh had higher indices than women and Kinh. Married or reunited people had higher HRQoLs than those who were widowed. The group with less than a primary school education had lower indices than other groups. HRQoL indices increased with a higher

Table 3: Functioning assessment according to general characteristics.

Variables	Functional limitation Mean	SD	p	*Post hoc*[‡]
Age groups				
60 s[a]	1.609	0.811	0.000	a < b < c
70 s[b]	2.012	0.940		
Over 80[c]	2.548	1.089		
Gender				
Male	1.718	0.887	0.000	
Female	2.038	1.015		
Ethnicity				
Kinh	1.936	0.981	0.086	
Non-Kinh	1.775	0.947		
Location				
Plain	1.940	0.987	0.080	
Mountain	1.786	0.932		
Marital status				
Married/reunion[a]	1.766	0.942	0.000	a < c
Single/divorced/separated[b]	1.906	0.904		
Widowed[c]	2.126	1.001		
Education				
Under primary[a]	2.202	1.101	0.000	a > b, c, d
Primary[b]	1.850	0.909		
Secondary[c]	1.667	0.817		
High school and higher[d]	1.681	0.838		
Religion				
Yes	1.730	0.627	0.514	
No	1.909	0.982		
Working status				
Unemployed & retired	2.061	1.063	0.017	
Still working	1.857	0.944		
Household size				
1-2 people	1.875	0.929	0.766	
3-4 people	1.848	0.946		
5-6 people	1.942	0.979		
Over 7 people	1.930	1.067		
Wealth quintile				
Richest	1.800	0.880	0.083	
Richer	1.874	0.910		
Middle	1.840	0.959		
Poorer	2.096	1.073		
Poorest	1.905	1.018		
Health insurance				
Yes	1.940	0.997	0.134	
No	1.817	0.917		
Recent smoker[*]				
Yes	1.572	0.786	0.055	
No	1.828	1.012		
Drinks in a month[†]				
Yes	1.574	0.759	0.000	
No	2.142	1.184		

Table 3: Continued.

Self-rated health status				
Good[a]	1.310	0.592		
Normal[b]	1.739	0.806	0.000	a < b < c
Bad[c]	2.608	1.086		
BMI				
Severely underweight[a]	2.591	1.214		
Moderately underweight[b]	2.047	0.921		
Mildly underweight[c]	2.004	0.971	0.000	b, c, d, e < a d < c
Normal range[d]	1.769	0.924		
Overweight[e]	1.814	0.851		
Number of NCDs				
0[a]	1.505	0.625		
1[b]	1.894	0.846	0.000	a < b, c < d
2[c]	2.016	0.913		
3 and over[d]	2.233	0.964		

*n = 192, †n = 198; ‡LSD.

self-rated health status. Participants within a normal BMI range had higher indices than those who were underweight, and particularly those who were severely underweight had significantly lower indices than those who were moderately underweight, mildly underweight, and within the normal weight range group. A greater number of noncommunicable diseases were associated with lower HRQoL indices.

Multiple regression analyses were performed to identify the determining factors of elderly participants' HRQoL (Table 5). Model 1 used socioeconomic variables as independents, and Model 2 included additional variables to examine the effects of health-related factors after controlling socioeconomic variables. As shown in Table 5, the factors of age, self-rated health status, BMI, and number of NCDs were significant determinants of elderly participants' HRQoL.

3.5. Healthcare Needs

3.5.1. Needed Healthcare Related Information. The number of respondents who expressed a need for health-related information was 387 (54.3%). These needs were categorized into seven areas: disease management, diet, pain management, exercise, general health, disease prevention, the health system, and others (Figure 2). The information requested most often pertained to disease management (27.53%). Information was also requested for chronic diseases such as hypertension, arthritis, musculoskeletal diseases, diabetes, stomach, and rheumatoid diseases. Older adults were most interested in degenerative diseases than other acute diseases. In particular, the category of pain management accounted for 9.3% of the requests. The respondents expressed a need for healthy lifestyle–related information on diet (13.67%) and exercise (8.51%). General health information (6.73%) and that for disease prevention (3.5%) were also desired by the aged. Lastly, requests for practical information to help them assess a health facility's quality accounted for 1.12% of the requested information.

3.5.2. Needed Home Healthcare Services. The number of participants who needed home healthcare services including rehabilitation was 154 (21.6%). The health problems for which respondents want home healthcare services or rehabilitation were categorized and summarized in Figure 3. The majority of needs related to caring for their own diseases (62.78%), and the rest to promoting their own health and well-being (11.62%), such as learning how to maintain a healthier life, and clarifying what appropriate care is for the elderly. The most frequently requested home healthcare service pertained to musculoskeletal diseases (40.1%), and included requests for walking-aids, help recovering motor function, and relief from muscle-aches. Other needs for home healthcare services related to caring for those with cardiovascular disease (11.1%), and sensory/dermatological problems (7.6%).

4. Discussion

The results of this study are consistent with previous studies that found epidemiological patterns shifting from a predominance of communicable diseases to noncommunicable diseases in Vietnam [19, 20]. Of this study's participants, 79% self-reported having a chronic disease that increased their households' financial burdens. Interestingly, cardiovascular disease, diabetes, and cancer were rarely reported in this study, although they are the leading causes of death in Vietnam [21]. It is possible that elders may not be aware of the symptoms and progression of these diseases, and find them when they are in a later stage. Screenings and regular health checkups may be critical for the elderly population, to ensure early detection and disease prevention.

The study's findings are not consistent with those of a previous systematic literature review that found a significant relationship between recent smoking behaviors, alcohol consumption, and the level of functioning. We suspect that this is because the systematic literature review primarily included

Table 4: Health-related quality of life according to socioeconomics and health status.

Variables	Health-related quality of life Mean	SD	p	*Post hoc*[‡]
Age groups				
60 s[a]	0.883	0.140	0.000	a > b > c
70 s[b]	0.838	0.148		
Over 80[c]	0.759	0.239		
Gender				
Male	0.872	0.140	0.001	
Female	0.828	0.190		
Ethnicity				
Kinh	0.840	0.172	0.048	
Non-Kinh	0.873	0.172		
Location				
Plain	0.840	0.171	0.059	
Mountain	0.869	0.175		
Marital status				
Married/reunion[a]	0.862	0.160	0.013	a > c
Single/divorced/separated[b]	0.833	0.214		
Widowed[c]	0.823	0.184		
Education				
Under primary	0.797	0.216	0.000	a < b, c, d
Primary	0.858	0.858		
Secondary	0.886	0.124		
High school and higher	0.879	0.123		
Religion				
Yes	0.847	0.110	0.980	
No	0.846	0.173		
Working status				
Unemployed & retired	0.826	0.196	0.076	
Still working	0.853	0.164		
Household size				
1-2 people	0.860	0.138	0.145	
3-4 people	0.865	0.117		
5-6 people	0.839	0.192		
Over 7 people	0.824	0.211		
Wealth quintile				
Richest	0.860	0.142	0.358	
Richer	0.845	0.176		
Middle	0.862	0.163		
Poorer	0.827	0.160		
Poorest	0.837	0.215		
Health insurance				
Yes	0.842	0.179	0.288	
No	0.857	0.155		
Recent smoker[*]				
Yes	0.880	0.141	0.416	
No	0.863	0.137		
Drinks in a month[†]				
Yes	0.889	0.119	0.593	
No	0.877	0.175		

Table 4: Continued.

Self-rated health status				
Good[a]	0.932	0.048		
Normal[b]	0.878	0.117	0.000	a > b > c
Bad[c]	0.730	0.244		
BMI				
Severely underweight[a]	0.739	0.234		
Moderately underweight[b]	0.789	0.217		
Mildly underweight[c]	0.825	0.180	0.000	a < b, c < d
Normal range[d]	0.867	0.154		
Overweight[e]	0.872	0.123		
Number of NCDs				
0[a]	0.914	0.072		
1[b]	0.854	0.167	0.000	a > b, c > d
2[c]	0.832	0.177		
3 over[d]	0.772	0.221		

*n = 192, †n = 198; ‡LSD.

Table 5: Multiple regression coefficients for significant factors of HRQoL.

Variables†	Model 1			Model 2		
	β^*	SE	p	β	SE	p
Constant	0.886	0.040		1.006	0.047	
Age group	−0.051	0.009	0.000	−0.032	0.008	0.000
Gender	−0.024	0.014	0.096	−0.016	0.013	0.226
Ethnicity	0.037	0.016	0.017	0.019	0.015	0.203
Marital status	0.004	0.008	0.608	0.002	0.007	0.833
Education	0.015	0.007	0.036	0.010	0.007	0.142
Self-rated health				−0.076	0.010	0.000
BMI				0.018	0.006	0.005
Number of NCDs				−0.022	0.006	0.000
R^2		0.093			0.233	

*Unstandardized coefficients; †reference category: age 60–69, male, non-Kinh, married/reunion, under primary school, good self-rated health, severely underweight, and having no NCDs.

research studies that had been conducted in highly developed countries [21].

The results of this study were similar to those of Hoi et al.'s study [3], which reported that the HRQoL of older people in rural Vietnam was affected by economic status, educational level, and marital status. After controlling for the effects of socioeconomic variables, this study's regression analysis indicated that self-rated health status, BMIs, and the number of NCDs were significant predictors of HRQoL. Thus, the quality of life among older people may be greatly increased by moving toward healthy lifestyles that include healthy diets and exercise, chronic disease management, and subjective well-being.

Meanwhile, even though more people recognize the importance of healthy lifestyles in modern society, older people's smoking and drinking habits are not easily changed. An et al. [22] reported that adults living in urban areas were more knowledgeable about the harmful health effects of active and passive smoking than those living in rural areas, and these significant differences in knowledge were related to access to health information. The fact that more than half of the participants in this study required health information from health professionals indicates a need to develop strategies for providing information efficiently to elderly people in rural areas.

The results of this study documented the various needs for healthcare and rehabilitation services among Vietnam's elderly population. Physical disabilities and functional limitations are common among older people [23] and lead to adverse consequences such as dependency and morbidity, the increased utilization of healthcare, and a need for supportive services and long term care [24]. Hairi et al. [24] reported that the prevalence of functional limitations was 20% in older Malaysians, and advancing age, gender (more women than men), the presence of arthritis, and having a depressive symptomology were significantly associated with functional

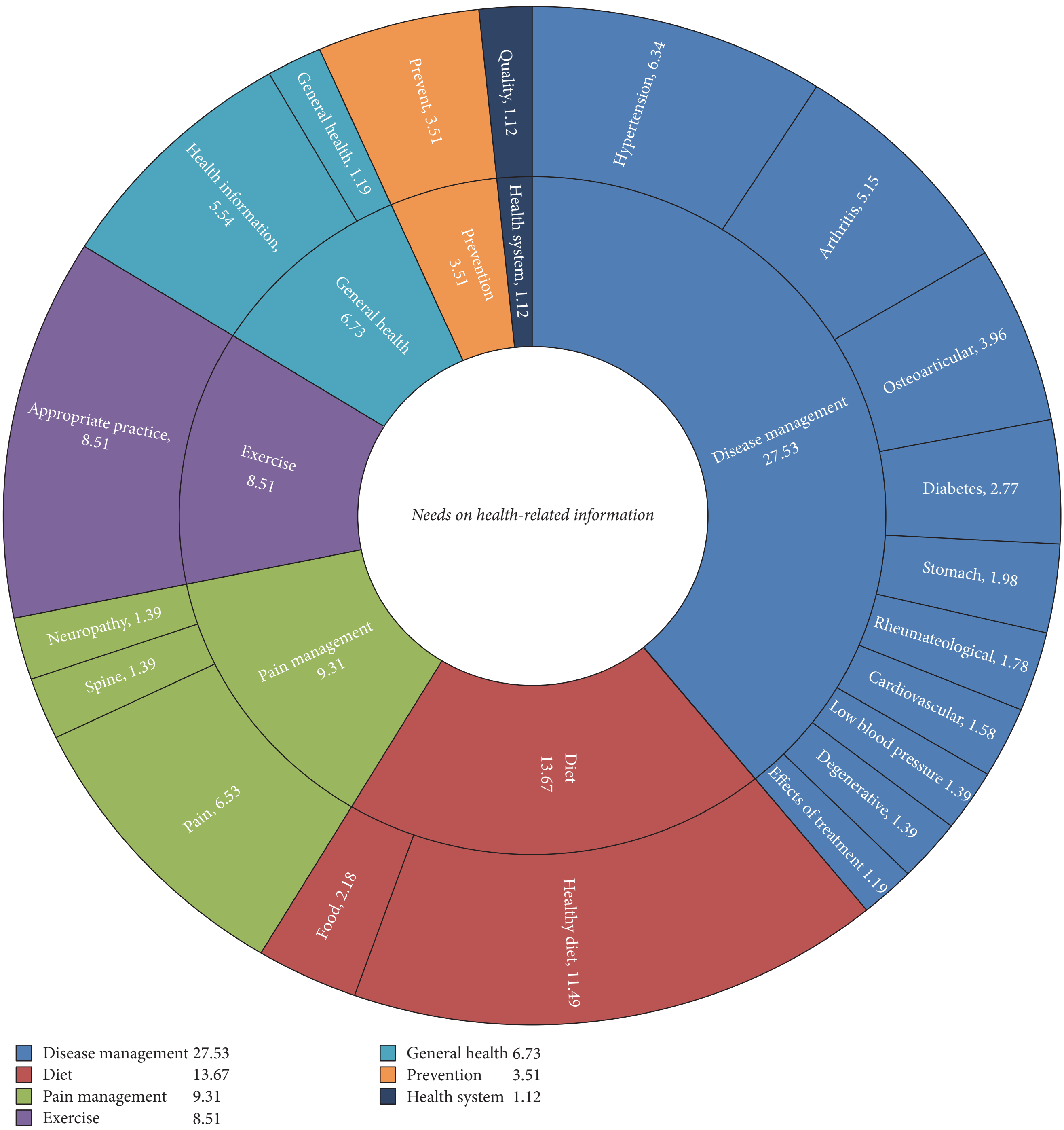

Figure 2: Needs on health-related information.

limitations. This study found that elders were in great need of obtaining health information to manage chronic illness and improve their health in general by adopting healthy lifestyles.

Along with the increase in the proportion of the population that is aging, and the increasing prevalence of noncommunicable diseases, readily accessible community-based primary care is critical. A Vietnamese commune health center is located in a community which covers 25,000 people. The roles of these centers should be strengthened to address effectively the elderly population's needs for health care services, particularly in rural areas. The WHO has emphasized the importance of community-based primary health services. Community health centers may become critical healthcare service providers for managing chronic illnesses,

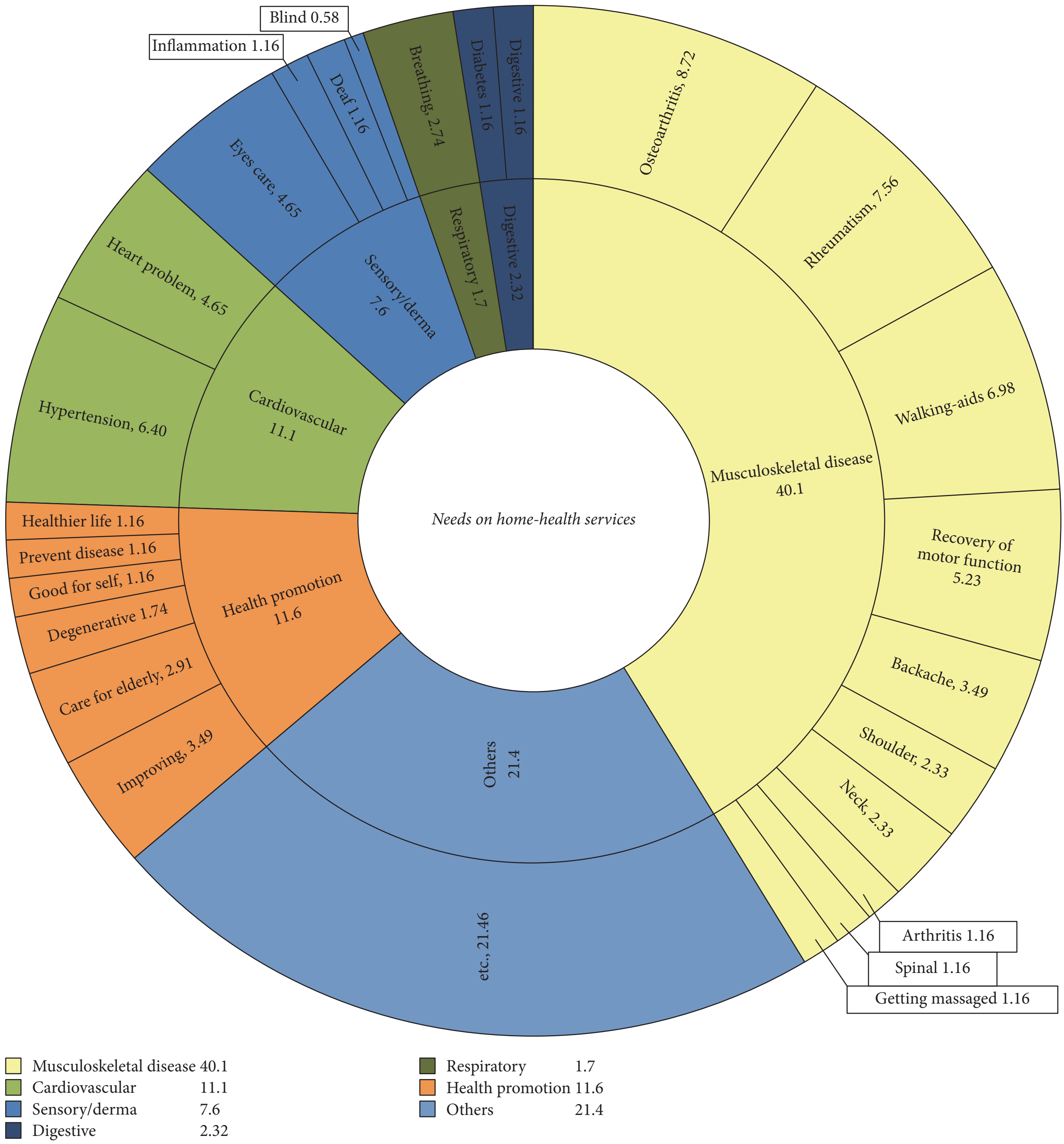

Figure 3: Needs on home health care services.

promoting healthy lifestyles and behaviors, reducing health risks, preventing diseases, promoting health, and improving the elderly population's quality of life.

The study's findings are limited by certain factors. First, the study's participants were limited to the elderly living in the rural Quoc-Oai district of Hanoi, using stratified proportion sampling, and quota assignment. Thus, to validate the generalizability of the results for the rural elderly in Vietnam, the study should have involved more participants from different regions and districts. Second, the data was collected through a survey questionnaire, and the information obtained from the study participants was assumed to be accurate. Further research is required to examine the correlates and predictors of health outcomes, and to investigate the effectiveness and feasibility of community health center-based, nurse-led, chronic illness management programs for the rural elderly in Vietnam.

5. Conclusions

The aging proportion of Vietnam's population is growing rapidly. The burden of providing healthcare for noncommunicable diseases continues to increase as a consequence. It is vital that health challenges and the healthcare needs of older adults be assessed. Furthermore, it is important that healthcare services be easily accessible and address the elderly population's increasing needs for chronic illness management, risk reduction, help adopting healthy lifestyles, and improving their quality of life.

Disclosure

K.-S. Bang is a Faculty Member at the College of Nursing, Seoul National University in Seoul, South Korea. Her major is child health nursing. S. H. Tak is also a Faculty Member at the College of Nursing, Seoul National University in Seoul, South Korea. Her major is geriatric nursing. J. Oh is a Faculty Member at JW Lee Center for Global Medicine, Seoul National University, South Korea. T. Q. Trung is a Vice Dean, Faculty of Nursing and Midwifery at the Hanoi Medical University, Vietnam. J. Yi and S.-Y. Yu are doctoral students at the College of Nursing, Seoul National University.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

K.-S. Bang planned the study's design, wrote the background section, supervised the data analysis, and revised the manuscript. J. Oh contributed to the acquisition of data, gave administrative and technical support, and reviewed the manuscript. S. H. Tak interpreted the data, wrote the discussion section, and provided critical revision of the manuscript. T. Q. Trung was responsible for explaining Vietnam's health situation and approved the final version to be published. J. Yi and S.-Y. Yu analyzed the data and prepared the Methods and Results. All the authors discussed the entire contents of this manuscript.

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Research Article

Household Financial Burden and Poverty Impacts of Cancer Treatment in Vietnam

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Purpose. This paper aims to analyze the household financial burden and poverty impacts of cancer treatment in Vietnam. *Methods*. Under the "ASEAN CosTs in ONcology" study design, three major specialized cancer hospitals were employed to assemble the Vietnamese data. Factors of socioeconomic, direct, and indirect costs of healthcare were collected prospectively through both individual interviews and hospital financial records. *Results*. The rates of catastrophic expenditure based on the cut-off points of 20%, 30%, 40%, and 50% of household's income were 82.6%, 73.7%, 64.7%, and 56.9%, respectively. 37.4% of the households with patient were impoverished by the treatment costs for cancer. The statistically significant correlates of the impoverishment problem were higher among older patients (40–60 years: 1.77, 95% CI 1.14–2.73; above 60 years: 1.75, 95% CI 1.03–2.98); poorer patients (less than 100% national income: 29, 95% CI 18.6–45.24; less than 200% national income: 2.89, 95% CI 1.69–4.93); patients who underwent surgery alone (receiving nonsurgery treatment: 2.46, 95% CI 1.32–4.59; receiving multiple treatments: 2.4, 95% CI 1.38–4.17). *Conclusions*. Lots of households were pushed into poverty due to their expenditure on cancer care; more actions are urgently needed to improve financial protection to the vulnerable groups.

1. Introduction

Cancer is known as a very severe disease in which malignant tumors and neoplasms develop uncontrollably and create serious harm to the human organs [1]. Cancer is found to be the leading cause of death worldwide. It was estimated that, in 2013, there were 14.9 million new cases of cancer and the number of deaths due to cancer was 8.2 million, which created a heavy burden of cancer worldwide (around 196.3 million DALYs) [2]. The economic impact of cancer is enormous for both the person with cancer and the society as a whole. The total economic impact of premature death and disability from cancers worldwide in 2008 was $895 billion. The three types of cancers that caused the most global economic impacts were lung cancer ($188 billion), colon/rectum cancer ($99 billion), and breast cancer ($88 billion) [3]. As the costs of treatment for cancer are usually substantial, many households and individuals with cancer are facing financial catastrophes or are even pushed into poverty because of the costs [4–6]. The household financial burden from chronic diseases impacted more on the poor and vulnerable populations [7]. Poor households are more likely to suffer disproportionately from the financial effects of the costs of treatment for cancer [6].

Like other developing countries, Vietnam is undergoing a rapid epidemiological transition resulting in an increase in chronic noncommunicable diseases, especially cancers [8]. According to Vietnam Ministry of Health, approximately

74.3 percent of the total disease burden in Vietnam was caused by noncommunicable diseases (NCDs) with cancer among the top ten causes. In Vietnam, it is estimated that about 150,000 people are newly diagnosed with cancer and more than 75,000 die of the disease every year. The costs of treating six common cancers, breast, ovary, liver, colon, stomach, and pharynx, accounted for 0.22 percent of the country's GDP in 2012 [9]. In Vietnam, household financial burdens caused by chronic diseases, including cancer, are now substantial. Households with NCD patients (including cancer cases) were 2.3 times more likely to be impoverished due to healthcare payment than other households [10]. Households that lived in slum areas and belonged to the poor or poorest socioeconomic groups were significantly associated with increased impoverishment because of healthcare spending on treatment for chronic diseases, including cancer [11].

Cancer prevention and control in Vietnam is still facing a number of challenges such as lack of comprehensive actions from involved stakeholders, unavailability of services for cancer screening and early detection at grassroots level of care, and shortage of human capacities and financial resources [9, 12]. Specifically, for example, even though tobacco control policies have been strengthened, the current cigarette excise tax in Vietnam is still low (only 65% of cigarette price before VAT or 41% of retailed price [13]) as compared to the level of at least 70% of retail price recommended by the World Health Organization [14] so its impacts on prevention of cigarette-related cancers is still limited. While the coverage of health insurance in Vietnam is now about 85%, the benefit package of health insurance scheme is not high. The insurance card holders have to be responsible for the remaining part of the costs (copayments) which are sometimes very high. In healthcare facilities, there are still no official regulations on cost containment, especially on the application of advanced medical technologies and expensive medicines. Fee-for-service is still the main provider payment method which tends to increase healthcare payment as well as financial burden on households in Vietnam [9].

Vietnam is now implementing the National Strategy for Cancer Control up to 2010 and 2020 with five main objectives: (1) reducing the incidence of tobacco-related cancers by 30%, compared to the year 2000; (2) ensuring HBV vaccination coverage for all newborns; (3) reducing breast, cervix, mouth, and rectum cancers mortality rates; (4) decreasing the proportion of advanced stage cancers from 80 to 50%; and (5) establishing a community-based terminal care system for cancer patients and ensuring sufficient supplies of essential drugs. One of the proposed strategies is to improve the use of scientific evidence in the planning, management, and policy-making process. In this context, more research on various aspects of cancer prevention and control is needed. While scientific evidence shows the rapid rise of the burden caused by cancers in Vietnam, little is known about the extent to which households in the country suffer from financial catastrophe or impoverishment caused by the disease. This paper aims to analyze the household financial burden and poverty impacts of cancer treatment in Vietnam.

2. Methods

2.1. Study Design and Study Subject. This is a facility-based study using prospective approach. This study was conducted as part of a regional study on the economic and health impact of cancer in eight countries in the ASEAN (Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam), the ASEAN CosTs in ONcology (ACTION) study [15]. This is a longitudinal cohort study conducted on a sample of 10,000 cancer patients. Patients diagnosed with cancer for the first time were consecutively recruited. Patients were interviewed at baseline (after diagnosis), three months, and 12 months. The primary outcome is incidence of financial catastrophe following treatment for cancer, defined as out-of-pocket healthcare expenditure at 12 months. Greater details of the study protocol can be found elsewhere [16].

2.2. Study Sites. Three major national level cancer centers in Vietnam were purposively chosen for this study, including Oncology Department of Bach Mai Hospital (located in the north, with more than 2000 staff and 1900 beds), Vietnam National Cancer Hospital (located in the north, with 800 staff and 1000 beds), and Ho Chi Minh City Oncological Hospital (located in the south, with more than 1000 staff and 1400 beds).

2.3. Data Collection. Data were collected from May 2012 to August 2014. Three data collecting periods were implemented including baseline and 3-month and 12-month follow-ups. Face-to-face interviews with cancer patients and their relatives were conducted by trained hospital nurses. The research tool was built by the ACTION Group, which was adjusted by the nation's context and was back translated to the local language. Data related to socioeconomic factors and direct and indirect expenditure on healthcare were collected from individual interviews; medical records were taken from the hospital system [16].

2.4. Variables and Definitions. To measure the financial catastrophe and impoverishment of household, the following definitions were applied during data analyses process.

2.4.1. Out-of-Pocket Payments (OOP). The term out of pocket referred to household spending at the point they received health services. These services include either inpatient services or outpatient services. Nonmedical spending such as transportation, food, or accommodation was also included into OOP payments. The reimbursements from health insurance were excluded from patients out of pocket.

2.4.2. Catastrophic Expenditure. Catastrophic heath expenditure occurs when a household's total out-of-pocket health payments equal or exceed a certain level (20%, 30%, 40%, and 50%) of household's income (household's income could be understood as the household's capacity to pay) [17].

2.4.3. Impoverishment. A nonpoor household is impoverished by healthcare payments when it becomes poor after paying for health services. Decision number 09/2011/QD-TTg issued by Vietnam Ministry of Labour, Invalid and Social

Affairs on the norms for poor households was applied to classify poor and nonpoor households [18].

2.5. Data Analysis. Stata statistic software version 12 was used to analyze the data. Both descriptive and analytical statistics were performed. Logistic regressions were used to identify correlates of impoverishment due to healthcare payments. The dependent variable was dummy variable on impoverishment. Independent variables include gender, education, income, age, occupation, health insurance coverage, type of treatment (surgery alone, chemical or radiology or medicine alone, and combination of surgery and other treatments), grade of tumor, and type of cancer. A significance level of $p < 0.05$ was used.

2.6. Ethical Consideration. All three local institutional ethics committees approved the study. Information sheet was given to all invited participants and written consent was given by each participant to join the study. The study protocol was approved by the Ethical Review Board of the Vietnam Ministry of Health.

3. Results

3.1. General Characteristics of the Study Participants. During the study period, after exclusions due to patient or doctor refusals, 1,916 cancer patients were recruited into the study. The 3- and 12-month follow-up interviews were completed by 1,141 patients (59.6%) (patients were still alive and responsive to the survey). There were no significant differences in other sociodemographic, clinical, and economic characteristics of the recruited patients and those included in the analysis. Generally, the majority of participants were female (71%), from 44 to 60 years (53.3%), completed secondary or high school (58.6%), and did not have a paid work (63.2%). 74.9% of the study participants had health insurance. Most of them came from households with total annual income 200% higher than the basis of national income (41.5%). Breast cancer was the most common type of oncology (27.1%). 75.2% of screened tumors were graded as type III. Most patients received multiple treatments (56.5%).

3.2. Household Out-of-Pocket Payments for Cancer Treatment. Table 1 presents the total amount of money that household with cancer patient paid for healthcare services (OOP) during 12 months. The mean, median, and standard deviation of the OOP were 43.9, 33.4, and 51.3 million VND, respectively. The OOP were higher among patients (1) of male gender; (2) 44–60 years old; (3) with highest education level; (4) having paid work; (5) not having health insurance; (6) having income at 100%–200% of national level; (7) suffering from breast cancer; (8) having cancer stage II; and (9) receiving multiple treatments.

3.3. Patterns of Catastrophic Expenditure and Impoverishment. The rates of catastrophic expenditure and impoverishment are presented in Figure 1. The rates of catastrophic expenditure based on the cut-off points of 20%, 30%, 40%, and 50% of household's income were 82.6%, 73.7%, 64.7%, and 56.9%, respectively. 37.4% of the households with patient were impoverished by the treatment costs for cancer. Table 1 shows the patterns of catastrophic health expenditure and impoverishment by patient's characteristics.

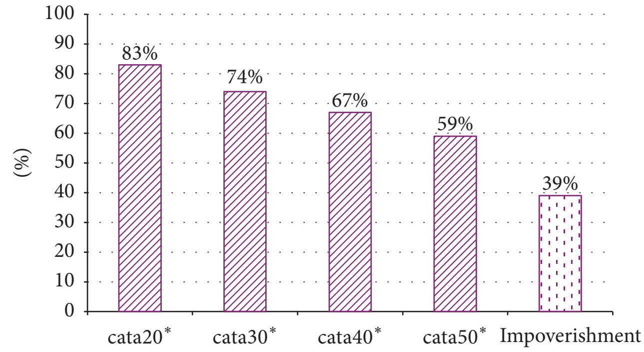

FIGURE 1: The rates of catastrophic expenditure and impoverishment among Vietnamese cancer patients. *Household had catastrophe expenditure if total medical expenditure equals or exceeds 20%/30%/40%/50% of total household income, respectively.

The rates of financial hardship were higher among patients who (1) were 44–60 years old; (2) did not have health insurance; (3) suffered from breast cancer; (4) had cancer stage II; and (5) received multiple treatments.

3.4. Correlates of Impoverishment. Table 2 presents the results of logistic regression analysis of the correlates of impoverishment problem among the cancer patients. After controlling of confounding variables, the statistically significant correlates of the impoverishment problem were as follows.

3.4.1. Age. The odds of being impoverished were higher among older patients as compared to the younger ones (OR for the group aged 44–60 years versus the group aged 44–60 years was 1.77; 95% CI: 1.14–2.73; OR for the group over 60 years versus the group 44–60 years was 1.75, 95% CI: 1.03–2.98).

3.4.2. Income. The odds of being impoverished were higher among poorer patients as compared to the better offs (OR for the group with income below national income level versus the group with income 200% of national income level was 29, 95% CI: 18.6–45.24; OR for the group with income 100%–200% of national income level versus the group with income over 200% of national income level was 2.89, 95% CI: 1.69–4.93).

3.4.3. Type of Treatments. Patients who underwent surgery alone had the lowest odds of being impoverished (OR for the patients who received chemotherapy or radiotherapy or hormonal therapy or biopharmaceutical therapy alone versus those who underwent surgery alone was 2.46, 95% CI: 1.32–4.59; OR for the patients who got multiple treatments versus those who underwent surgery alone was 2.4, 95% CI: 1.38–4.17).

Table 1: Patterns of household out-of-pocket payments and financial burdens for cancer treatments.

Subgroup	Total household out of pocket, million VND			Rate of catastrophe expenditure (using different cut-off points), %				Rate of impoverishment, %
	Mean	Median	SD	20%*	30%*	40%*	50%*	
Gender								
Male	46.206	33.65	66.772	79.8	71.6	65.6	56.8	33.5
Female	42.848	33.35	43.518	83.7	74.6	64.3	56.9	39
Age group								
<44	39.871	30	42.84	82.6	69.7	57.5	48.1	31.4
44–60	47.966	36.65	58.879	84.9	77.3	69.7	63.2	40.5
>60	38.058	30.39	37.504	76.8	69.5	60.6	51.6	37
Education level								
No school	40.688	25.6	69.24	82.1	76.9	66.7	59	41
Primary school	41.648	29.127	78.525	85.5	77	69.4	60.9	38.3
Secondary/high school	43.279	34	38.455	82.8	74.7	66.7	59.3	39.3
Vocational school	59.184	50.6	56.787	84.8	78.8	66.7	57.6	27.3
College/university	46.563	36.325	40.645	77	63	49.1	40.6	29.7
Working status								
Do not have paid work	42.404	31.27	56.289	81.4	73.6	65.5	58.9	38.4
Have paid work	46.232	37.2	41.442	84.5	73.8	63.3	53.3	35.7
Health insurance status								
Do not have health insurance	44.37	34.086	40.042	86.4	78.4	70.4	64.1	42.9
Have health insurance	43.634	33	54.586	81.3	72.1	62.8	54.4	35.6
Household income level								
<100% of mean national income	42.942	28.26	81.72	95.9	94.7	92.4	90.6	21.8
100%–200% of mean national income	46.1	38.5	38.738	96.7	92.3	89.2	83.3	73.3
>200% of mean national income	40.888	34.41	31.513	68.1	52.3	34.4	22.9	10.3

Table 1: Continued.

Subgroup	Total household out of pocket, million VND			Rate of catastrophe expenditure (using different cut-off points), %				Rate of impoverishment, %
	Mean	Median	SD	20%*	30%*	40%*	50%*	
Cancer site location								
At hematological/blood system	28.533	19.925	23.966	59.1	50	40.9	27.3	13.6
At respiratory system	43.404	36	43.524	79.1	73.3	63.4	56	39.3
At digestive system	41.951	32.95	37.096	81.1	69.9	63.1	54.4	29.1
At reproductive system	40.558	32	37.037	84.9	76.8	68.1	58.4	37.8
Breast cancer	52.845	41.5	55.29	89.3	82.2	71.8	66.3	49.2
Other cancer	37.457	25	69.969	78.1	65.8	57	48.7	29.4
Cancer grade								
Cancer grade I	42.577	31.5	35.513	84	74.1	65.4	59.3	37
Cancer grade II	52.464	37.56	66.386	89.6	83.2	72.8	64.9	43.6
Cancer grade III	41.823	33	48.098	80.8	71.4	62.7	54.8	36
Type of treatment								
Surgery alone	28.236	20	40.612	76.5	62.7	53.6	43.1	25.5
Nonsurgery treatments**	43.347	35	63.233	78.6	70.5	62.4	55.8	35.3
Multiple treatments***				86.1	78	68.5	60.7	41.4
Overall (n, %)	*43.818*	*33.35*	*51.322*	*848 (82.6)*	*766 (73.7)*	*701 (64.7)*	*616 (56.9)*	*406 (37.4)*

*Catastrophe expenditure if total medical expenditures equal or exceed 20%/30%/40%/50% of total household income, respectively. **Nonsurgery treatments include chemotherapy or radiotherapy or hormonal therapy or biopharmaceutical therapy alone. ***Multiple treatments include both surgery and nonsurgery treatments.

Table 2: Logistic regression analysis of the correlates of impoverishment.

Subgroup	Odd ratio	95% CI	
		Lower bound	Upper bound
Gender			
Male	Ref		
Female	1.03	0.64	1.65
Age group			
<44	Ref		
44–60	1.77*	1.14	2.73
>60	1.75*	1.03	2.98
Education level			
No school	Ref		
Primary school	0.73	0.27	1.93
Secondary/high school	0.88	0.34	2.24
Vocational school	1.05	0.25	4.37
College/university	1.22	0.42	3.51
Working status			
Do not have paid work	Ref		
Have paid work	1.16	0.79	1.71
Health insurance status			
Do not have health insurance	Ref		
Have health insurance	0.99	0.66	1.5
Household income level			
<100% of mean national income	29.0*	18.6	45.24
100%–200% of mean national income	2.89*	1.69	4.93
>200% of mean national income	Ref		
Cancer site location			
At hematological/blood system	Ref		
At respiratory system	1.76	0.34	9.07
At digestive system	1.39	0.27	7.22
At reproductive system	1.89	0.36	9.99
Breast cancer	2.19	0.42	11.42
Other cancer	1.71	0.33	8.78
Cancer grade			
Cancer grade I	Ref		
Cancer grade II	0.6	0.26	1.39
Cancer grade III	0.77	0.36	1.64
Type of treatment			
Surgery alone	Ref		
Nonsurgery treatments**	2.46*	1.32	4.59
Multiple treatments***	2.40*	1.38	4.17

*Statistically significant result. **Chemotherapy or radiotherapy or hormonal therapy or biopharmaceutical therapy alone. ***Multiple treatments include both surgery and nonsurgery treatments.

4. Discussion

This research generates new evidence on household financial burden and poverty impacts of cancer treatment in Vietnam. The evidence is expected to be used in health planning, management, and policy-making process in the country and elsewhere. We have shown that a large proportion of Vietnamese households with cancer patient incurred catastrophic level of health expenditure and/or were pushed into poverty because of the costs of healthcare services (the rates of catastrophic expenditure based on the cut-off points of 20%, 30%, 40%, and 50% of household's income and impoverishment due to treatment costs for cancer were 82.6%, 73.7%, 64.7%, and 56.9%, resp.).

This finding is in line with other international studies which have proven the fact that household financial burden caused by cancer treatment is substantial. The ACTION study reported that, a year after diagnosis, only 23% of cancer patients from eight countries in ASEAN were alive with no financial catastrophe [15]. A study in Haiti found that two-thirds of women with breast cancer were to face financial catastrophe because of the treatment costs [19]. Similarly, cancer treatment is considered as the most costly healthcare service in India. Households with cancer patients spent 36–44% of their total annual expenditures and they might lose around 3% of the family workforce to spare time for patient care [20]. Another study from Pakistan also showed that the financial burden of cancer care was substantial and mostly borne by the patient or the family. Most of the time, the average monthly cost of treatment far exceeded the monthly household income [21]. Some recent literature reviews also indicated that households with chronic disease patients, including cancer patients, had to spend a substantial share of their incomes on care for these diseases and many households faced catastrophic health expenditure and impoverishment as a result of the spending [7, 22].

Our study revealed that the rates of catastrophic expenditure and impoverishment due to treatment costs for cancer were higher among older patients and those belonging to lower income families, having no paid work, not enrolled in health insurance scheme, and receiving multiple treatments methods. However, only older age, lower income, and receiving multiple treatment methods were shown to be statistically significant correlates of the impoverishment problem. At regional level, the ACTION study found that having a below-average income, having no health insurance, not having paid work, and having attended not higher than primary education were all associated with higher odds of experiencing catastrophic expenditure [15] and this reinforces the current knowledge of relationship between socioeconomically disadvantaged conditions and higher risks of financial hardship [23]. There should be financial support programs to cover the treatment costs of cancer and to help socioeconomically disadvantaged cancer patients to cope with the challenging situation.

Financial protection is the most important aspect of health insurance coverage but this research illustrates that, in Vietnam, health insurance had no statistically significant impacts on protecting households with cancer patients from impoverishment due to cancer treatment costs. This may be partially explained by the limitations of benefit packages of the health insurance programs. It fact, health insurance in Vietnam now covers part (0%–100%) of healthcare costs of the insured patients depending on the type of healthcare services. The insurance card holders have to be responsible for the remaining part of the costs (copayment). Many medicines and diagnostic tests for cancer are not covered by health insurance so the copayments are very high. Most of the studies on the impacts of health insurance in Vietnam consistently found that insurance has only a modest effect on reducing out-of-pocket payments [24–28]. Reform of health insurance benefit package to improve financial protection is needed in Vietnam. The ACTION study also found that, in the ASEAN region, the relationship between health insurance and financial catastrophe was not particularly strong [15].

The study has several limitations. Firstly, for pragmatic reasons, only hospitalized cancer patients were included and the findings may not be representative for the whole picture of household financial burden and poverty impacts of cancer treatment in Vietnam. Secondly, the low response rate (50%) may cause biases in the study finding. Thirdly, reporting income is regarded as a sensitive issue in Vietnam and the figures on income are normally underreported. Fourthly, only direct costs were included in this study. Sometimes, indirect costs (productivity loss and household suffer) are substantial and higher than the direct costs [6, 29]. Finally, the comparison of findings of this study with those from other contexts is just indicative because of the differences in definition and methods of calculation of catastrophic payment and impoverishment.

5. Conclusion

This study shows that a large proportion of Vietnamese households with cancer patient incurred catastrophic level of health expenditure and/or were pushed into poverty because of the costs of healthcare services. Socioeconomically disadvantaged cancer patients were particularly vulnerable to negative impacts of cancer treatment costs. Given the evidence, policy actions that can remove financial barriers and provide financial protection to the cancer patients as well as other groups of population are urgently needed. Cancer prevention strategies, especially effective tobacco control measures such as raising cigarette tax, would be prioritized actions in Vietnam. Other general interventions such as revision of health insurance package and reform of provider payment methods should be done as soon as possible. There should also be financial support programs to cover the treatment costs of cancer and to help socioeconomically disadvantaged cancer patients to cope with the challenging situation. A more representative study on household financial burden and poverty impacts of cancer treatment in Vietnam (using community-based approach or with larger sample size) is needed. We also need to include the indirect costs (opportunity costs) due to cancer treatment in the coming studies.

Disclosure

The funder of the study had no role in study design, data analysis, data interpretation, or writing of this paper.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Research Article

Examining Health Inequalities in Latvia: A Decade of Association between Socioeconomic Position and Perceived Health Status

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The relationship between socioeconomic position (SEP) and population health is contextual. This study identifies the determinants of SEP producing health inequalities in the Latvian population. We also estimate the proportional contribution of different socioeconomic strata- (SES-) related determinants in Latvian health inequalities and measure the changes in the relative contributions of such determinants over the period 2005–2015. Using the household survey data (2005–2015), we construct a principal component analysis based SES index. A regression-based concentration index (CI) is our measure of health inequality to examine the distribution of perceived health status. Finally, we identify and estimate the contribution of predictors of health inequalities by decomposing CI with Oaxaca-Blinder decomposition. SES-related health inequalities have declined from 2005 (CI: 0.201) to 2015 (CI: 0.137) in Latvia—better-off Latvians enjoyed better perceived health during that period. The proportional contributions of education and working status have increased in 2015 compared to 2005. Although we have generated the first evidence to suggest policy relevant measures in addressing Latvian health inequalities, our decomposition method explains the extent of variation in perceived health instead of covariance between health and SEP.

1. Introduction

Health inequality is defined as differences in health among individuals or between groups (socioeconomic, geography, education, race, etc.). The linkage between increasing income inequality and the worsening of health status is well documented [1–7]. People who live in the lowest socioeconomic strata (SES) are vulnerable to ill health [8, 9]. Lochner et al. [10] have summarized evidence of a high risk of death when living in a high-inequality environment.

Less education, low income or unemployment, and lower position in the hierarchal society have a strong positive association with lower levels of perceived health [11]. Gilson [12], Wilkinson [13], Manor et al. [14], Mcisaac and Wilkinson [15], Kunst and Mackenbach [16], Blaxter [17], and Jones and Moon [18] conclude that in-country distribution of material deprivation reflects in-country health differences, *ceteris paribus*. Marmot et al. [19] have suggested that different mechanisms operate at the top and at the bottom of SES.

Eikemo et al. [20, 21] argue that although individual factors account for variations in health, welfare state arrangements is an important factor explaining variations in population health between countries. Rodgers [22] suggests that levels of health serve as a signal of the socioeconomic environment where people live and reflect the level of deprivation of the society. Research has established a strong association between socioeconomic position (SEP) and perceived health; however, such association is confounded by factors that are often not global, rather determined by socioeconomic and political contexts [23].

Economic development literatures advocate the recognition of health as a reflection of societal well-being, when the development is in transition [24, 25]. Furthermore, the concern for poverty and inequality necessitates the focus of interest not in health status that is apparent in the society as a whole but in the health status of different socioeconomic groups [26]. Socioeconomic inequalities in health are a major challenge for health policy effectiveness because a reduction in the burden of health problems in worse-off (more material deprivation) groups offers an enormous potential for improving the average health status of the population as a whole.

Research has found existence of health inequalities in central and eastern European societies [27, 28]. A few studies have also documented SES-related health differences in the Baltic Republics: Lithuania, Latvia, and Estonia [11, 29–31]. Monden [29] has further concluded that substantial inequalities in self-assessed health exist in the Baltic States and such inequalities were stable during the last few years of the last century. Monden [11] has demonstrated a relatively stronger effect of income and working status on perceived health compared to educational achievements for Latvians.

Following the disintegration of the USSR, the social and economic reforms that are taking place in Latvia are likely to have an effect on daily life [32–34]. The accession of Latvia to the European Union in 2004 has triggered further a new phase of development but did not end the ongoing social reforms. The distributions of the determinants of perceived health status are time variant phenomena. So, the importance of time and timing in understanding the causal links between exposures and outcomes cannot be ignored. Material factors are linked to conditions of economic hardship, as well as to health damaging conditions in the physical environment (e.g., housing conditions, physical working environment, etc.). Thus, health inequalities result from the differential accumulation of exposures and experiences that have their sources in the material world.

Unlike financial resources which can be equalized over time with the payment of interests, developmental inputs are not necessarily fungible. A clear gradient exists in the effect of exposure to disadvantaged SEP on health; the extent of health risk increases with each additional level of exposure [35]. Using a long-run panel (1994–2013) from waves of Russian Longitudinal Monitoring Survey datasets, Paul and Valtonen [36] infer that SES specific mean and the distribution of perceived health status within SES are important guides to improve average health of the Russian population. Although the lasting effect of transitional changes on the Latvian population health is an obvious phenomenon, the evidence is limited [37, 38].

This study is to examine health inequalities in Latvia and identify the determinants of SEP producing such health inequalities in the Latvian population.

We

(1) examine the distribution of perceived health across Latvians of different socioeconomic groups;

(2) estimate the proportional contribution of different SES-related determinants in Latvian health inequalities;

(3) measure the changes in the relative contributions of such determinants over the period 2005–2015.

2. Materials and Methods

We used data from 11 (2005–2015) waves of household survey (Latvian Statistical Bureau: http://www.csb.gov.lv/en/dati/statistics-database-30501.html). This annual survey contains an array of information on the economic, social, demographic, and health characteristics of respondents, their households, and the environments where they live. Following accession to the EU in 2004, the survey design, stratification, and sampling units remained consistent from 2005 onwards. The survey uses weights to account for nonresponse and attrition. Our data (Table 1) was cross-sectional time series with a total of 124,934 respondents nested in 6,599 households.

Our dependent variable for the analysis was perceived (self-assessed) health (SAH). Individuals were asked, "How would you evaluate your health?" And the response was recorded on a five-point Likert scale with the answers "very good," "good," "average—not good but not bad," "bad," and "very bad." SAH variables have been widely used in literatures [39–42] that analyze the socioeconomic health gradient.

SES is a multifaceted concept; no direct measure is available. Heterogeneity in relevant individual and household circumstances, intertemporal consumption smoothing, and interpersonal income sharing entail that neither measured current income (it is instructive that, in the same setting, Ravallion and Loskhin (2001) find evidence that many "nonincome" factors at the individual and household levels impinge on perceived economic welfare in Russia at given current incomes or expenditures on consumption deflated by standard poverty lines) nor consumption (there are uncertainties about how to best normalize for heterogeneity in consumption needs, such as stemming from demographic differences between households (Pollak, 1991); for example, the poverty lines used as deflators may not correctly weight differences in household size or demographic composition) is a particularly good proxy for economic welfare, as relevant to perceived health status. Principal component analysis works on the covariance or correlation matrix to extract the directions in the multivariate space that is the "most informative," that is, reflecting the greatest variability.

We used adult equivalent household income (the household income was deflated to the value of 2005; we calibrated the household income as per adult equivalent using the modified OECD scale; the Statistical Office of the European Union (EUROSTAT) adopted in the late 1990s the so-called "OECD-modified equivalence scale"; this scale, first proposed by Haagenars et al. (1994), assigns a value of 1 to the household head, of 0.5 to each additional adult member, and of 0.3 to each child), working status, level of education, ownership of fixed assets (ownership of house), ownership of durable assets (washing machine, computer, and car), available floor space in square meter for living, and living standards (condition of dwelling unit and availability of enough heating provision in the household) to arrive at weights for the proxies of material affluence. The inclusion of a sufficiently broad range of variables and also a continuous variable (available floor space in square meter) enabled us to construct the SES indices without the problems of truncation (truncation implies even distribution of SES spread over a narrow range,

Table 1: Data.

Year of survey	Number of respondents	Present from the previous wave	Attrition (%) corresponding to the previous wave
2005	7913	—	
2006	9071	4258	46.18
2007	9270	4270	52.92
2008	10910	4559	50.81
2009	12207	5236	52.01
2010	12999	5743	52.95
2011	13503	6141	52.76
2012	12964	6159	54.39
2013	12442	6122	52.78
2014	11929	5927	52.36
2015	11726	5696	52.25

which makes differentiation between the SES difficult) [43]. We validated sampling adequacy for the variables used by Kaiser–Meyer–Olkin score (0.80 and above). We used the weighted sum of standardized variables to obtain the SES score. Finally, households were grouped into SES quintiles. We also measured inequality in income by the Gini index ($G = 2\text{covar}(y, r_y)/N\overline{y}$, where $\text{covar}(y, r_y)$ is the covariance between income (y) and ranks of all households according to the income (r_y) ranging from the poorest household (rank = 1) to the richest (rank = N), N is the total number of households, and $\overline{y}$ is the mean of the adult equivalent household income (YitzhakI, 1994; Lerman and Yitzhaki, 1984)).

We standardized [44, 45] perceived health status applying an indirect method of standardization (indirectly standardized health is the difference between observed and expected health where expected health for an individual is the average health of individuals with the same levels of standardizing variables as the individual; with groups, expected health for an SES group is the weighted average of health levels conditional on the standardizing variables, where the weights are the proportion of the SES group population in the subgroups defined by the standardizing variables). We estimated the correlation of confounding variables (age, gender, diagnosed chronic diseases, and presence of physical limitation) with perceived health status conditional on nonconfounding variables (region and SES). This regression-based approach (see (1)) "corrects" the actual distribution of perceived health status by comparing it with the distribution that would be observed if all individuals in the group had their own age, gender, diagnosed chronic diseases, and presence of physical limitation characteristics but the same mean age, gender, diagnosed chronic diseases, and presence of physical limitation effect as the entire population.

$$y_i = \alpha + \sum_j \beta_j x_{ji} + \sum_k \gamma_k z_{ki} + \epsilon_i, \tag{1}$$

where y_i is perceived health status; i denotes the individual; and α, β, and γ are parameter vectors. x_j are confounding variables (age, gender, diagnosed chronic diseases, and presence of physical limitation), which we standardize, and z_k are nonconfounding variables (region and SES), which we do not standardize but control for in order to estimate partial correlations with the confounding variables. The Newey-West (a regression method that corrects for heteroskedasticity and autocorrelation) estimator estimates ($\widehat{\alpha}, \widehat{\beta}_j, \widehat{\gamma}_k$) the individual values of the confounding variables (x_{ji}), and sample means of the nonconfounding variables ($\overline{z}_k$) are then used to obtain the predicted, or "x-expected," values of the perceived health status $\widehat{y}_i^x$:

$$\widehat{y}_i^x = \widehat{\alpha} + \sum_j \widehat{\beta}_j x_{ji} + \sum_k \widehat{\gamma}_k \overline{z}_k. \tag{2}$$

Estimates of indirectly standardized perceived health are

$$\widehat{Y}_i^{\text{IS}} = Y_i - \widehat{Y}_i^X + \overline{Y}, \tag{3}$$

where

(i) $\widehat{Y}_i^{\text{IS}}$ is indirectly standardized, perceived health status;

(ii) Y_i is actual health;

(iii) $\widehat{Y}_i^X$ is x-expected health;

(iv) $\overline{Y}$ is overall sample mean.

In the next step, following the principles of previous analyses [46, 47], we dichotomized the five-scaled measure into a binary variable [48], "perceived health" (1 = good, i.e., responded as "very good," "good," and "average"; 0 = not good, i.e., responded as "bad" and "very bad").

The conventional regression-based statistical methods report the magnitude and the direction of association between SEP and health status of the individual but ignore possibility of variance in the effect of explanatory variables across distribution. Further, such traditional methods cannot reflect the extent of health differences across SES of the population and thus do not allow for comparison over time [46]. Therefore, we used the health concentration index (CI) as our measure of SES-related inequality.

The concentration curve plots the cumulative proportion of perceived health (y) against the cumulative share of the population ranked by SES variables. The curve lies below the 45° line (diagonal) of equality, if perceived health is concentrated among the better-off and above the 45° line (diagonal) of equality, if perceived health is concentrated among the worse-off. The CI is defined as twice the area between the concentration curve and the diagonal (the line of equality):

$$\mathrm{CI} = \frac{2}{n\mu}\sum_{i=1}^{n} y_i R_i - 1, \tag{4}$$

where n is the sample size and R denotes the individual's fractional rank (position of the individual) in the SES distribution. μ is the mean of the binary variable y (perceived health status) whose distribution across SES is the subject of interest. For $\mu > 0$ (if $y = 0$ for all i, CI is undefined), the minimum value of CI is equal to $\mu - 1 + (1/n)$, and the maximum value is equal to $1 - \mu + (1/n)$.

For a given $\mu > 0$, the maximum of the CI is when the poorest j individuals have a value of y equal to zero, and the richest $n - j$ individuals have a value of y equal to one.

Therefore, $\mu = (n - j)/n$ and $\mathrm{CI} = 1 - \mu + 1/n$. For the large samples, the $1/n$ term vanishes, and the minimum and maximum tend to $\mu - 1$ and $1 - \mu$, respectively [49]:

$$R_i = \sum_{j=1}^{i-1} w_j + \frac{1}{2} w_i, \tag{5}$$

where $w_0 = 0$. R_i denotes the weighted cumulative proportion of the population up to the midpoint of each individual weight and is bounded in the (0; 1) interval. R_i represents the cumulative distribution function of SES and indicates the individual's position within the SES distribution.

We estimated CI from regression of a transformation (correction of the standard error across SES correlation owing to the rank nature of the regressor) of the perceived health status on the fractional rank in SES distribution [50].

CI becomes positive if health (i.e., perceived health status) is concentrated among the better-off, negative if health (i.e., perceived health status) is concentrated among the worse-off, and zero if no inequality is observed. Thus, CI can also be interpreted as the slope of a line passing through the heads of an army of people, ranked by their SEP, with the height for each individual proportionate to the value of his/her perceived health status, expressed as a fraction of the mean for the group.

Finally, we used the framework (based on the assumption of a linear additive relationship between the health variable y and a set of explanatory variables x; i.e., $y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i$ (x_k are sets of health determinants and ε is the disturbance term)) [51] to decompose the concentration index for y (perceived health) when CI is expressed as

$$\mathrm{CI} = \sum_k \left(\frac{\beta_K \overline{X}_K}{\mu}\right) C_k + \frac{\mathrm{GC}_\varepsilon}{\mu}, \tag{6}$$

where

$\overline{X}_K$ is the mean of x_k;

C_k is the concentration index for x_k (defined analogously to C);

GC_ε is the generalized concentration index for the disturbance term.

Thus, concentration index (CI) is equal to a weighted sum of the k regressors. The weight for regressor k is the elasticity of y for x_k. The residual component reflects health inequality not explained by systematic variation across SES in the regressors. The estimated health elasticity *(marginal effect)* of determinant k is written as $\widehat{\eta}_k = (\widehat{\beta}_K \overline{X}_K/\mu) C_k$, where $\widehat{\eta}_k$ is the relative change of y statistically associated with a one-unit change of the corresponding x_k (a weighted average of the health levels of the sampled population when higher weights are attached to the worse-off than the better-off). Wagstaff et al. [51] argue that changing contributions can be caused either by changes in the elasticities of η_k or by changes in the distribution of C_k of x_k.

3. Ethics

This study uses secondary data collected from perpetual surveys. The datasets are anonymously coded with no individual identification identifiable by the user. The users have explicit authorization to use the datasets made available for analysis.

4. Results

The proportion of respondents from 45 years and above age groups consistently increased in 2015 compared to 2005 and so was the representation of females in the same age groups (Table 2). Representation of rural respondents and respondents with own house was less in 2015 compared to 2010. Although the proportion of respondents with chronic disease and disability (presence of physical limitation) increased consistently from 2005 onwards, reporting of bad and very bad perceived health decreased consistently during the same period. Female respondents followed the same trend in reporting perceived health status as observed for the overall study population. In our study sample, the proportion of respondents with denial of needed healthcare attributable to the increased distance to the health facility from the respondent's residence increased consistently. The respondents from dwelling units of the not bad condition, having ownership of car and computer, with ease of survival (ability to make both ends meet), and with ease of repaying loan increased in 2015 compared to 2005. Reported neighborhood safety was found to be much better in 2015 compared to earlier years. The adult equivalent household income increased 3.6 times in 2015 from 2005 while the distance between the mean and median of the adult equivalent household income decreased by 2.5% (from 24% in 2005 to 21.5% in 2015). However, the Gini coefficient registered a positive shift by 2.2% during the study period. Our objectively determined SEP reflected a consistent increase of respondents from the poorest quintile with a consistent decrease of respondents from the richest quintile in 2015 compared to 2005. Table 2 exhibits a statistically significant association between perceived health and SEP of

Table 2: Descriptive statistics.

Variables	2015	2010	2005
Age group (in years)	[N = 11726]	[N = 12999]	[N = 7913]
<30	16.66	21.15	22.63
31–44	18.97	19.41	21.99
45–60	27.16	26.98	25.15
61–74	21.31	20.05	19.69
75+	15.90	12.41	10.54
Age group (in years) by gender	Female (%)	Female (%)	Female (%)
<30	14.20	18.38	19.35
31–44	16.96	17.92	20.51
45–60	26.09	26.25	24.86
61–74	23.08	21.72	21.92
75+	19.67	15.73	13.36
Settlement of residence (%)			
Urban	71.87	65.49	¥
Rural	28.13	34.51	¥
Perceived health status distribution (%)			
Very good	3.83	3.82	2.46
Good	37.14	39.67	30.54
Average	40.06	36.77	43.62
Bad	15.21	15.81	17.33
Very bad	3.76	3.93	6.05
Perceived health status (%) (gender = female)			
Very good	2.99	3.03	1.64
Good	33.97	36.30	26.94
Average	41.50	38.55	44.32
Bad	17.07	17.60	19.91
Very bad	4.47	4.52	7.19
Denial of needed healthcare services Reason (% of denied services)	12.36	21.35	29.66
Affordability	59.48	63.32	57.43
Distance	3.32	2.76	2.09
Work/childcare	5.87	7.31	11.74
Chronic disease (%)	46.01	38.87	37.72
Disability (%)	42.58	34.57	34.66
Working status (%)			
Employed	49.31	41.85	50.12
Retired	31.20	29.99	29.42
Ownership of house (%)	81.72	85.41	78.91
Overall condition of dwelling unit as bad (%)	24.92	25.19	39.90
Vulnerable neighborhood security/safety (%)	11.69	22.40	21.82
Ownership of car (%)	55.12	51.43	42.61
Ownership of computer (%)	71.72	59.64	33.67
Ease of survival; ability to make both ends meet (%), with difficulty	78.49	85.48	86.98
Ease of paying the loan (%), with difficulty	72.52	82.47	79.81
Adult equivalent household income (€)			
Mean	11627.90	8899.24	3197.83
Median	9570.68	7195.88	2578.24

Table 2: Continued.

Variables		2015		2010		2005
Gini coefficient		0.365		0.360		0.357
Socioeconomic position (SEP) distribution (%)						
Poorest		24.00		22.12		21.36
2nd poorest		21.07		21.47		21.13
Middle		19.17		19.89		19.94
2nd richest		18.54		18.36		19.34
Richest		17.22		18.16		18.23
Distribution of perceived health (%) across SEP	Average	Bad and very bad	Average	Bad and very bad	Average	Bad and very bad
Poorest	26.13	52.21	24.32	43.88	18.82	39.30
2nd poorest	23.65	23.50	23.43	27.94	20.74	29.86
Middle	19.04	13.13	21.14	14.09	21.93	15.77
2nd richest	17.63	7.93	16.84	9.00	19.92	10.57
Richest	13.55	3.23	14.28	5.09	18.59	4.50
Chi-square (χ^2)		0.000		0.000		0.000

¥: no data of the variable is available in the wave.

Table 3: Distribution of perceived health status.

SES quintile	2015 [N = 11726]			2010 [N = 12999]			2005 [N = 7913]		
	Δ	^Mean-std.	^^Mean	Δ	^Mean-std.	^^Mean	Δ	^Mean-std.	^^Mean
Poorest	−0.51	2.88	3.38	−0.32	2.94	3.26	−0.15	3.13	3.27
2nd poorest	−0.35	2.76	3.11	−0.11	2.86	2.97	0.08	3.00	2.93
Middle	−0.08	2.69	2.78	0.12	2.80	2.68	0.24	2.92	2.67
2nd richest	0.08	2.68	2.60	0.25	2.75	2.51	0.31	2.87	2.57
Richest	0.21	2.60	2.40	0.30	2.65	2.35	0.38	2.77	2.39
Total	−0.08	2.70	2.78	0.04	2.80	2.76	0.07	3.01	2.94
HI		0.137 (0.004)			0.155 (0.004)			0.201 (0.006)	

^Mean of indirectly standardized perceived health status; ^^mean of perceived health status (1 = very good, 2 = good, 3 = average, 4 = bad, and 5 = very bad); Δ: difference between the mean of indirectly standardized perceived health and the mean of perceived health status; HI: health inequality index. Figures in parentheses indicate bootstrapped standard error.

the respondents; average and below perceived health status increased consistently for respondents from the poorest quintile in 2015 compared to 2005.

Although the difference for total between the mean of indirectly standardized perceived health and the mean of perceived health status was found to be negative in 2015, the value of the mean of standardized variant of perceived health status was higher than that of nonstandardized variant for better-off individuals implying that inequalities were better avoided for the better-off individuals when the effects of age, gender, diagnosed chronic diseases, and presence of physical limitation (disability) were controlled (Table 3). The negative values indicated a smaller value of the mean of standardized variant of perceived health status compared to the same for nonstandardized variant reflecting that some of the inequalities in the distribution of perceived health were unavoidable and due simply to the effect of age, gender, diagnosed chronic diseases, and presence of physical limitation (disability) of the sampled population. Thus, the trend reflected consistently more unavoidable inequalities for the relatively worse-off individuals over the period. Also, the distance of standardized variant of mean perceived health status of the poorest quintiles from the standardized variant of mean perceived health status of the sampled population increased in 2015 compared to 2005. Although a negative shift of HI in 2015 compared to 2005 (Table 3) reflected a better perceived health status for the worse-off individuals, the difference in mean of nonstandardized variant of perceived health status between the richest and poorest quintiles increased during the period.

Table 4 shows the results from decomposing CI (i.e., factor level contributions to SES-related health inequalities for 2015, 2010, and 2005). A negative contribution of a factor to the CI indicated (see (6)) that the factor correlates positively with perceived health status, and such contribution is concentrated among worse-off individuals (more material deprivation); likewise, the reverse is true. The negative contribution of ownership of a house in 2015 implied that the concentration of ownership of a house among better-off individuals increased the concentration of bad and very bad perceived health among the worse-off individuals. Similarly, the probability of being employed (working status) in 2005 was associated with lower risks of bad and very bad perceived health status. The positive contribution of age in all the years moderated observed inequality; elderly respondents

Table 4: Factors contributing to health inequalities.

Effects and contributions of predictor variables	Change in contribution (%) 2005–2015	2015 [N = 11726]		2010 [N = 12999]		2005 [N = 7913]	
		Marginal effect	% contribution	Marginal effect	% contribution	Marginal effect	% contribution
Age	15.9	−0.33	25.70	−0.54	29.10	−0.71	41.60
Gender (=female)	2.0	0.01	−0.50	−0.00	0.10	−0.04	1.50
Education	−2.6	0.03	9.70	0.02	10.00	0.03	7.10
Working status	−14.0	0.04	10.90	0.02	5.80	−0.01	−3.10
Household income	0.4	0.71	43.90	0.49	34.30	0.88	44.30
Ease of survival	1.2	0.01	7.20	0.02	9.80	0.02	8.40
Ownership of house	0.5	−0.01	−0.40	0.01	0.60	0.0	0.10
Regional effect			0.30		7.30		¥
Residual		0.002		0.002		−0.001	

¥: no data for the variable is available in the wave.

were vulnerable to a higher risk of having bad and very bad perceived health status even if they were members of better-off SES. The contribution of gender in the health gradient was found to be insignificant. In the decomposition of total change in the concentration index between 2005 and 2015, level of education and working status (being employed) were the most important variables in their contributions to SES-related health inequalities. There was a substantial reduction of proportional contribution of geography (in-country regional difference) in 2015 compared to 2010 (Table 4). The effects of residuals (unexplained factors) were substantially low for all the years.

5. Discussion

Using cross-sectional time series data from the Latvian household survey (2005–2015), we examined health inequalities in Latvia and identified the determinants of SEP producing such health inequalities in the Latvian population. While examining the distribution of perceived health status across different socioeconomic groups, we found that the overall concentration of positive perceived health favored worse-off individuals in 2015 compared to earlier years but to some extent (−0.08) inequalities in perceived health status remain unavoidable (after controlling the effect of age, gender, diagnosed chronic diseases, and presence of physical limitation) in 2015. The differences between the means of standardized and nonstandardized variants of perceived health status were consistently negative for the poorest quintile of SES while the same was consistently positive for the richest suggesting that worse-off individuals carried consistently unavoidable inequalities in perceived health during the study period. Also, the difference between the means of standardized and nonstandardized variants of perceived health status between quintiles of SES increased by 35.85% favoring the richest in 2015 compared to 2005 (difference between the richest and the poorest quintiles: 53% in 2005, 0.62 in 2010, and 0.72 in 2015). Such evidence suggested that although the health inequality index of perceived health favored the worse-off individuals, the burden of unavoidable (after controlling the effect of age, gender, diagnosed chronic diseases, and presence of physical limitation) inequalities was strong and sustained on the poorest quintile of SES. When compared to the mean perceived health status (standardized and nonstandardized variant) between the richest and the poorest quintiles of SES, we found a gradient between SEP and perceived health status, a linear decrease in health that comes with decreasing SEP. This relationship between poverty (deprivation) and poor health status is congruent with established arguments [52–54]. Such observation is also in harmony with the pathways from SES to health that shapes individual responses to perceived health status [55].

When estimating proportional contribution of different SES-related determinants in Latvian health inequalities, we found that education, household income, and ease of survival in all the years, and working status (being employed) in 2015 and 2010 were the most important factors contributing to differences in perceived health status. The high contribution of working status in 2015 compared to earlier years supported earlier findings in Latvia [11]. Such an association of no work with a higher risk for poor health is also in agreement with studies from other European countries [21, 56]. The strong and positive effects of household income in the distribution of perceived health status and the associated trend (i.e., the +ve shift of Gini index, improved material affluence, i.e., increased number of respondents in the study population from dwelling units of not bad condition, having ownership of car and computer, and with ease of survival, i.e., ability to make both ends meet and with ease of repaying loan) were consistent with the established relationship between health and SEP.

With the attempt to measure changes in the relative contributions of such determinants over the period 2005–2015, we found a substantial reduction of proportional contribution of geography (in-country regional difference) in 2015 compared to 2010. This finding in conjunction with the reduced contribution of ownership of a house can be explained with the increased shift of respondents from rural to urban settlement (Table 2) in our study population during the study period. Although the relative contributions of the factors (determinants) identified $[(\widehat{\beta}_K \overline{X}_K/\mu)C_k]$ registered changes in the intervening period, overall contributions (97%+) of the factors to health inequalities in perceived health status remained unchanged over the decade (2005–2015).

The findings ((1) a +ve shift of Gini index by 1.4% and an increased contribution of household income to health inequalities by 28% in 2015 from 2010 and a −ve shift of health inequality index by 11.6% during the same period, and (2) a +ve shift of Gini index by 0.8% and a decreased contribution of household income to health inequalities by 22.6% in 2010 from 2005 and a −ve shift of health inequality index by 22.9% during the same period) established the notion that income alone could not explain changes in the distribution of perceived health status. An increased shift of the respondents from rural to urban settlement is presumed to be accompanied with improved access to publicly provided services and so the changes in the distribution of perceived health status can be plausibly [57] attributed to subjective perception of relatively better rank within SES during the study period. Further, such phenomena can also be decoded as the expressions of macroeconomic factors on happiness (fluctuations in negative affect) when the economy is still dynamic, open, and volatile [58].

The strengths of this study lie in (1) using the most recent waves (2005–2015) of survey datasets to generate evidence while the economic, social, and health systems reforms are in progress, (2) unfolding the evolution of perceived health gradient for Latvians since the accession to the European Union (EU), and (3) identifying the contributing factors to inequalities in perceived health and presenting changes in the extent of such contributions to overall inequalities in perceived health over the decade of accession to the EU.

This study has few limitations as follows. (1) Despite using cross-sectional time series data for a reasonably long period, the effect of a substantial high attrition rate on perceived health status cannot be ignored. Also, cross-sectional data have the potential for reverse causation (i.e., health status affecting SEP); (2) the perceived health status variable is a bounded variable, so the use of CI is based on the assumption that the level of inequality is the same irrespective of representation (attainment versus shortfall) and so our measurement of the health inequality is not a value neutral; and (3) the decomposition method used is one-dimensional focusing perceived health (i.e., the method explains the extent of variation in perceived health instead of covariance between health and socioeconomic positions). Further, it is also true that inherent biases attributable to individual heterogeneity associated with SEP influence the perceived health status.

6. Conclusions

This study contributes by examining the evolution of distributional differences in perceived health status for Latvia in recent times. We conclude with the empirical evidence that (1) a favorable health inequality index does not confirm a reduced burden of unavoidable inequalities in health on the worse-off group of the population and (2) the relative contributions of SES-related determinants to the production of health inequalities change over time. Notwithstanding few explicit limitations, this study generates evidence for insightful health policy development.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Authors' Contributions

Pavitra Paul was responsible for the concept, design, analysis and interpretation, and writing of the manuscript. Data acquisition and organization and literature search were carried out by Anželika Berķe-Berga. Hannu Valtonen performed critical reviews.

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