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THE IMMINENT OBESITY CRISIS IN ASIA AND THE PACIFIC: FIRST COST ESTIMATES

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Abstract

Over the past two decades, Asia and the Pacific have not only experienced rapid growth, but in parallel saw a rapid increase in overweight people and obesity. The latest available data indicated that over 40.9% of adults in the region are overweight compared to 34.6% in 1990. It is well documented that obesity and overweight are one of the main risk factors of non-communicable diseases. The rapid spread of excess weight thus implies significant additional costs for health systems and the economy as a whole. Despite the growing significance of this public health problem, we still lack estimates of direct and indirect costs caused by the obesity endemic for the region. This paper fills this gap by providing a first cost estimate for 42 Asia and the Pacific countries. Our estimations include both direct costs caused by additional medical expenditures as well as indirect costs due to higher morbidity and mortality of overweight and obese patients. Overall, our estimates suggest the total costs caused by obesity to be 12% of total health care expenditures or 0.78% of gross domestic product in the region. Obesity is thus a serious threat to the prosperity of the region and calls for urgent action.

Keywords: Cost-of-illness, obesity, overweight, Asia, Pacific

JEL Classification: I15, I19

Contents

1. INTRODUCTION

Over the past 3 decades Asia has seen fast economic development. Economic growth rates for the region have averaged more than 6% since the start of the millennium. Gross domestic product (GDP) per capita increased from US$4,279 at purchasing power parity (PPP) in 2000 to US$11,518 (at PPP) in 2015 (ADB Key Indicators for Asia and the Pacific 2016). Fast economic growth went hand in hand with a rapid fall in poverty and progress in various other dimensions, including in the area of public health. Especially the systematic deployment of vaccines and progress in sanitation have contributed to a rapid fall in communicable diseases. Whereas in 2000 about 20% of all deaths in the region were caused by communicable diseases, in 2015 the share had fallen to 13%. It does not mean that no further action is needed to fight communicable diseases. Vector borne diseases, such as malaria, are still widespread and a heavy burden to health systems, especially in the poorer countries of the region. However, the increase of non-communicable diseases is a clear trend and appropriate policy reactions need yet to be found.

Non-communicable diseases have various causes. The World Health Organization (WHO) identifies four modifiable risk factors of behaviors—tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol (WHO 2017). The second and third of these risk factors typically find their expression in overweight and obesity. Overweight is commonly defined as a body mass index (BMI) exceeding 25, while obesity starts when the BMI surpasses 30 (WHO 2016).

Today, the Asia and the Pacific region is home to the largest absolute number of overweight and obese people, equivalent to about 1 billion. In the Asia and Pacific region two out of every five adults in the region are either overweight or obese. Applying the ADB definition of subregions, the Pacific is the most overweight subregion in the world with an estimated number of 59% of adults being overweight and 20% being obese. Table 1 shows the prevalence of overweight in all 5 ADB subregions for 1990 as well as 2013. The change in figures has been most dramatic in Southeast Asia region where the prevalence of overweight and obesity increased by almost 40 percent from 1990 to 2013.

Public health experts are increasingly aware of the main determinants of the fast propagation in the region. Economic growth made food increasingly available at lower prices. While it helped to lower the incidence of stunting and wasting, it also increased the possibilities of overeating and excessive weight gain. One engine of growth in the region has been the shift from agriculture to manufacturing industries and more recently to services. Jobs in manufacturing and services typically require less physical activity and can lead to overweight. In addition, the rapid urbanization of Asia has been another contributing factor to the increase in overweight. Asia saw its urban population increase from about one third in 1990 to one half in 2015. Urbanization typically means a more sedentary life style, at work and at home. It is typically also associated with more meals out and longer commuting times. Public health experts have described this shift in eating pattern as global nutrition transition (e.g., Popkin et al. 2012).

Table 1: Prevalence of Overweight and Obesity in Asia and the Pacific

	1990	2013	% Change
Mean for Asia and the Pacific	34.6	40.9	18.3
Central Asia			
Armenia	45.4	53.0	16.7
Azerbaijan	49.4	63.4	28.3
Georgia	22.9	29.7	29.7
Kazakhstan	47.0	54.8	16.6
Kyrgyz Republic	48.1	50.8	5.6
Tajikistan	34.5	40.8	18.3
Turkmenistan	47.3	53.6	13.3
Uzbekistan	43.9	47.9	9.1
Mean for Central Asia	*42.32*	*49.25*	16.4
East Asia			
PRC	13.2	27.9	111.4
Rep. of Korea	25.2	32.3	28.2
Japan	20.2	23.3	15.3
Mongolia	41.3	49.4	19.6
Taipei,China	25.8	32.4	25.6
Mean for East Asia	25.14	33.06	31.5
South Asia			
Afghanistan	43.3	45.9	6.0
Bangladesh	8.0	16.9	111.3
Bhutan	31.5	35.3	12.1
India	17.3	20.1	16.2
Maldives	33.4	40.3	20.7
Nepal	9.1	13.0	42.9
Pakistan	27.1	33.1	22.1
Sri Lanka	19.3	26.2	35.8
Mean for South Asia	23.62	28.85	22.1
Southeast Asia			
Brunei	17.5	20.6	17.7
Cambodia	10.1	15.5	53.5
Indonesia	14.8	26.0	75.7
Lao PDR	19.3	24.6	27.5
Malaysia	38.3	46.3	20.9
Myanmar	14.7	18.2	23.8
Philippines	17.8	24.5	37.6
Singapore	30.7	38.2	24.4
Thailand	20.8	36.0	73.1
Viet Nam	5.8	13.1	125.9
Mean for Southeast Asia	18.98	26.30	38.6

continued on next page

Table 1 *continued*

	1990	2013	% Change
The Pacific			
Fiji	44.2	51.2	15.8
Papua New Guinea	39.1	42.9	9.7
Solomon Islands	59.5	64.8	8.9
Timor-Leste	4.7	4.9	4.3
Vanuatu	45.3	50.6	11.7
Palau	44.2	51.2	15.8
Marshall Islands	66.7	76.9	15.3
Micronesia	69.6	74.9	7.6
Samoa	80.3	84.0	4.6
Tonga	82.5	86.1	4.4
Kiribati	75.1	79.1	5.3
Mean for the Pacific	*55.57*	*60.60*	*9.1*

Source: Authors based on IHME data

While the prevalence, determinants, and consequences of overweight and obesity are thus rather well understood, the economic costs of overweight and obesity are still unknown for the region as a whole. Substantive research efforts have been undertaken in developed countries to estimate the costs of the condition. In the US the most recent studies estimate that every obese person has to spend approximately US$2,741 per year in additional health care costs (Cawley and Meyershoefer 2012). For Japan, the most recent estimates show a similar amount with US$1,537 (Nakamura et al., 2007) Furthermore, due to higher rates of absenteeism and lower productivity at work, overweight and obesity are estimated to cost US business up to US$66 billion annually (Hammond and Levine 2010). Similar numbers are known for European countries. In Germany, the additional medical costs are estimated to be 3.27% of health care expenditures (Lehnert et al. 2015). Even though Asia and the Pacific has the largest number of overweight and obese patients, the cost of the condition is yet largely unknown. To our knowledge the number of countries for which cost estimates are available is very limited. We were able to find estimates for five Asian economies—Japan; Republic of Korea; the People's Republic of China (PRC); Taipei,China; as well as Thailand. Section 3 of this paper will discuss the main finding of these country studies. However, the evidence for developing countries is sparser. In the next subsection we will first review the existing evidence of the costs of overweight and obesity in the Asia and the Pacific region. We will then discuss the strategies we employ in estimating the direct and indirect cost of overweight and obesity for all countries covered in this study.

The objective of this paper is to estimate the costs of overweight and obesity for the entire Asia and the Pacific region. When defining the region of Asia and the Pacific, we follow the definition of the Asian Development Bank, which counts 42 countries in the region. Our cost estimates include the direct costs as well as indirect costs of overweight and obesity. The direct costs are all additional health expenditures associated with the condition. The indirect costs cover the costs that are incurred due to higher morbidity as well as higher mortality.

The methods of estimating the direct and indirect costs can differ substantially. Direct costs can for example include or not include the costs due to transporting patients to

ambulatory treatment centers. Cost estimates are typically undertaken at the country level and require detailed data, especially on the cost of various medical procedures or on lower productivity. Yet, for most of countries in Asia and the Pacific such data is not publicly available or, in most cases, not available at all. We thus had to develop a new methodology to estimate the direct costs. Our approach relies on a number of assumptions which is due to the severe data limitation. Our estimations results should therefore not be considered as an exact point estimate, but rather as an indicative measure of the costs of overweight and obesity. We hope that our work will stimulate new discussion and provide incentives to conduct more research on the topic. The gravity of the problem definitely warrants additional efforts in this area.

Overall, we find that overweight and obesity result in direct costs that amount to 8.90% of health expenditure. We estimate that the indirect costs are as high as 3.46% of health care expenditure in the region. The total costs associated with overweight and obesity are about 0.78% of GDP. In monetary terms, this translates to US$166 billion. Both conditions thus have the potential to severely undermine the economic and human development of the region.

Interventions to curb the spread of overweight and obesity are multiple. They should target both the intake of food as well as physical activity. To be successful, policies need to take place within the realm of public health as well as beyond. The last section will briefly discuss various policy options.

This paper does not have the ambition to be exhaustive in terms of covering the topic of overweight and obesity. The focus of the paper is to develop new estimates for the costs of the condition in the Asia and Pacific region.

2. CURRENT AND FUTURE PREVALENCE OF OVERWEIGHT AND OBESITY IN ASIA AND THE PACIFIC

2.1 Definition of Overweight and Obesity

Overweight and obesity are the conditions wherein the body accumulates excess body fat to the extent that it impairs physical function and increases the risks of certain illnesses. The Body Mass Index (BMI) is the widely accepted method of classifying a person based on her/his weight and height. Essentially, a person's BMI is computed by dividing the weight in kilograms by the square of the height in meters ($\frac{kg}{m^2}$).

Based on the WHO definition (WHO, 2016), persons with a BMI greater than or equal to 25 are considered overweight while those with a BMI greater than or equal to 30 are considered obese. Since the underlying data used in this study uses these cut-offs, our cost estimates are also based on these cut-offs. However, one needs to note that this commonly used WHO definition is only one possible measure of the condition. There exist a number of alternative measures for overweight and obesity, such as the waist circumference, waist to height ratio, waist to hip ratio, or measure of body fat.

Furthermore, there have been repeated calls for a revision of the BMI. One of the main arguments made is that the onset of certain diseases associated with overweight occurs at a lower BMI than 25. Another related argument is that certain ethnicities have a different body type and have a higher ratio of body fat with an identical BMI. This argument was especially made for Asian people. Already in 1994, Wang et al. (1994) found that Asians tend to have a low BMI but high levels of body fat. A WHO group of

experts argued in The Lancet (2004) that the BMI cutoff values for metabolic risk in Asians varies between 22 and 25 BMI. As a consequence, Asian have a higher mortality risk at any given BMI above 25 compared to their US counterparts (Low et al. 2009; Wen et al. 2009; Shiwaku 2009). Another compounding factor is that Asians are more likely to develop central obesity, which is associated with a higher risk of developing cardiovascular and metabolic diseases (Thomas 2004). Several experts therefore argue to apply a cut-off for the Asia and the Pacific region. For example, in the case of Sri Lanka Wickramasinghe et al. (2011) proposed lower cutoff levels for children.

In our study we use the commonly applied cut-offs for BMI, namely 25 for overweight and 30 for obesity. As explained above, the current scientific evidence suggests that these cut-offs are rather high for the Asia and the Pacific region. As a corollary, our cost-estimates are probably downward biased. Once systematic estimates of the prevalence of overweight and obesity at different levels of BMI are available for the region, we intend to recalculate our cost estimation.

2.2 Data Sources

Overweight and Obesity Data

The main data used in this paper is sourced from the Institute for Health Metrics and Evaluation (IHME), University of Washington, Seattle, US. Due to the lack of trend data for the prevalence of overweight and obesity in many lower- and middle-income countries, the IHME developed a model-based approach to produce country-level estimates that are based on nationally-representative surveys, reports as well as published studies that included data for height and weight. To estimate the prevalence data on obesity and overweight by age, sex, country, and year, the IHME employs a spatiotemporal Gaussian process regression model with a 95% confidence interval. The estimation bias for the self-reported height and weight were corrected using mixed-effect linear regression. In our study, we utilized data on country-specific prevalence of BMI greater than or equal to 25 for both males and females.

Other Data

To match the data we collected from IHME, we gathered other information from several data sources. The data for male, female, and total population were downloaded from the United Nations Population Division “World Population Prospects: The 2015 Revision” while the data on total health care expenditure, consumer price index, and official exchange rate were downloaded from the World Development Indicators database of the World Bank. Based on the metadata of the World Bank, the total health care expenditure is defined as the sum of public and private health expenditure. This includes activities related to health care, family planning, nutrition, and emergency aid. On the other hand, consumer price index reflects the period average of the changes in the cost of acquiring a basket of goods and services for an average consumer. The Laspeyres formula was used to calculate this indicator. Meanwhile, the official exchange rate is calculated as the annual average of monthly exchange rate data for local currency unit relative to the US dollar.

Additionally, we included data on the GDP and GDP per capita of each country. These data were downloaded from the World Economic Outlook database (October 2016) of the International Monetary Fund. As explained on the World Economic Outlook website, the expenditure-based GDP that was used in our estimation was computed by subtracting the free on board (FOB) value of imports of goods and services from the

total final expenditures at purchasers' prices (including the FOB value of exports of goods and services). The computed GDP in local currency was then translated to US dollars using the yearly average of the market exchange rate. Meanwhile, GDP per capita was derived by dividing the converted GDP by the total population for that year.

Lastly, we collected information on the comparative prices of medical procedures in Asia. Although data on medical prices are relatively scarce, we obtained several comparative tables on prices of medical procedures in different Asian countries from several websites that promote medical tourism.[1] We used the comparative prices of heart bypass and angioplasty, as these procedures are commonly performed on overweight and obese individuals with high risk of heart disease.

Countries Covered

The countries included in our analyses are the 42 member countries of the Asian Development Bank (ADB). We used Japan as our reference country in our direct cost estimation. We follow ADB's classification of subregions in our discussions: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan are classified under the Central Asia subregion. The PRC; Republic of Korea; Japan; Mongolia; and Taipei,China are classified under the East Asia subregion. Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka are classified under the South Asia subregion. Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam are classified under the Southeast Asia subregion. And Fiji, Papua New Guinea, Solomon Islands, Timor-Leste, Vanuatu, Palau, Marshall Islands, Micronesia, Samoa, Tonga, and Kiribati are classified under the Pacific subregion.

2.3 Prevalence of Overweight and Obesity in Asia and the Pacific

Overweight and obesity have attracted the attention of public health experts for many years. However, the problem was mostly perceived as a public health issue for industrialized countries. Only more recently have we witnessed a rapid increase in the prevalence of excessive weight in many developing countries. Popkin et al. (2012) argued that the nutrition transition started in the developing countries in the early 1990s and led to a sharp increase in obesity rates in the years after. Obesity has increased even in the poorest countries in the world, including Sub-Saharan Africa and South Asia.

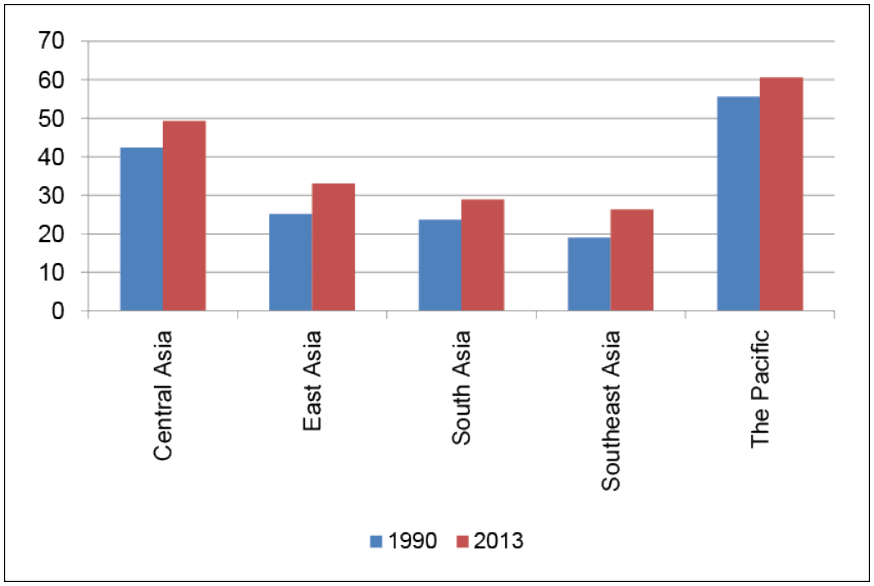
While overweight and obesity have become a global health problem, countries are struggling to curb the rising trend. Even developed countries with advanced public health systems have been largely unsuccessful in their fight against overweight and obesity. In 2011, the WHO announced that overweight and obesity has reached an "epidemic proportion." Today, most public health experts agree that obesity has to be considered a major public health concern all over the world.

[1] Some examples of these websites are: http://medicaltourism.com/Forms/price-comparison.aspx, http://www.health-tourism.com/philippines-medical-tourism/, http://formosamedicaltravel.com/medical-tourism-blog/tag/hip-replacement-cost-comparison/. Likewise, online magazines such as: Medical Travel Singapore, 2007 edition, Parkway Group healthcare and Medical Tourism Association Survey – August 2007 similarly present some information on the comparative prices of medical procedures.

The Lancet Medical Journal (2014) revealed that global obesity increased from 3.2% in 1975 to 10.8% among men, while it increased from 6.4% in 1975 to 14.9% in 2014 among women. Moreover, the WHO estimates that overweight and obesity are responsible for about 5% of global deaths in 2015 and continue to be a main contributor to the global disease burden.

The incidence of overweight and obesity has been rising in Asia and the Pacific region (Figure 1). In 2013, 40.9% of adults in this region were overweight and obese compared to 34.6% in 1990. When we divide the 42 countries into the five subregions, we note that obesity has risen everywhere. However, the level is rather different across subregions. Compared with Asia the Pacific region has by far the highest percentage of overweight and obese population, already by 1990. By 2013, the prevalence of these conditions had gone up further to an alarming 61%. Central Asia ranks second with almost 50% of the population considered overweight and obese in 2013. While these conditions appear to be relatively low in Southeast Asia, South Asia, and East Asia, it is very noticeable that the three subregions have witnessed the sharpest relative increases. In East Asia the prevalence increased by 31.5% between 1990 and 2013, in South East Asia by 22.1%.

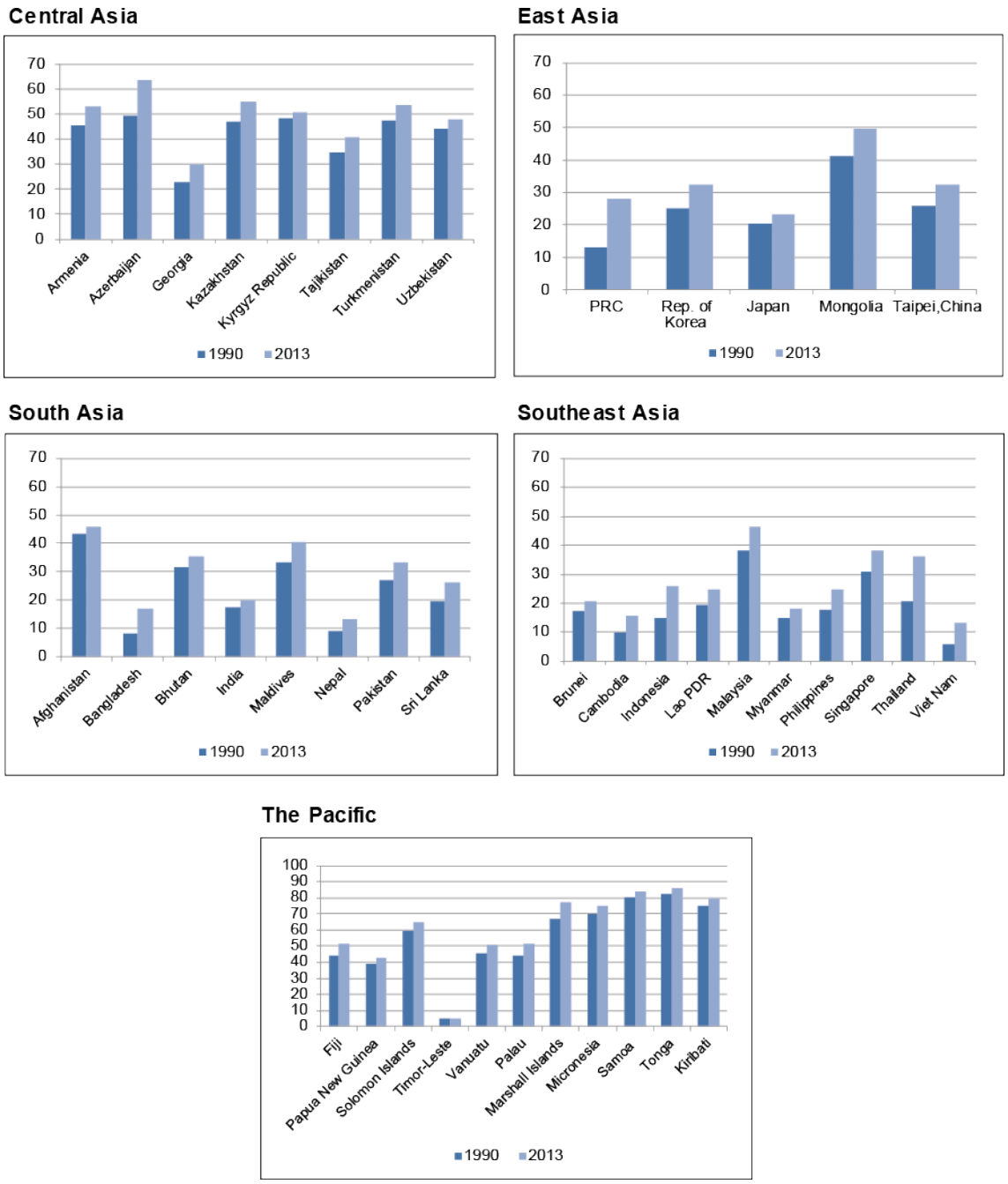
Figure 1: Prevalence of Overweight and Obesity in Asia and the Pacific
(% of total population)



Source: Authors based on IHME data.

A more detailed view (Figure 2) reveals that Central Asia is composed of countries with some of the highest prevalence of overweight and obesity in the whole of Asia. Five countries—Armenia, Azerbaijan, Kazakhstan, Kyrgyz Republic, and Turkmenistan—were observed to have more than 50% of the population overweight and obese in 2013. In Azerbaijan a noticeable increase in overweight and obesity rate from 49% in 1990 to 63% in 2013 was observed. Georgia on the other hand, appears to have had the lowest prevalence of overweight and obesity compared to all the countries in this region since 1990.

Figure 2: Prevalence of Overweight and Obesity by Specific Groups
(% of total population)



PRC = People's Republic of China.
Source: Authors based on IHME data.

The prevalence of overweight and obesity in East Asia seems low except for Mongolia, where it reached nearly 50% in 2013. One glaring observation, however, is that the rate of overweight and obesity more than doubled in the PRC from 13% in 1990 to 28% in 2013. This is of particular concern since the PRC is one of the most populous countries in the world. Overweight and obesity rates are also rising in Republic of Korea and Taipei,China.

Looking at the South Asia region, we see that Bangladesh appears to be following in the PRC's footsteps as overweight and obesity prevalence increased from 8% in 1990 to 17% in 2013. Nepal and Sri Lanka are also exhibiting a rapid increase in the number of overweight and obese people. Within this region, Afghanistan, Bhutan, Maldives, and Pakistan had rates above 30% in 2013.

In Southeast Asia, Indonesia and Thailand are showing alarming trends. The rate of overweight and obesity in Indonesia was around 15% in 1990 but this had escalated to 26% in 2013. A similar picture can be seen in Thailand where it rose from 21% in 1990 to 36% in 2013. Similarly, we observe a rapid increase in cases of overweight and obesity in Cambodia and the Philippines. Viet Nam has seen a similar increase—although it has one of the lowest overweight and obesity rates in the region, it rose from 6% in 1990 to 13% in 2013.

Overall in Asia, male adults in Malaysia and Singapore are among the most overweight, with a prevalence of 43.8% and 44.3%, respectively (The Lancet 2014). For female adults, Malaysia (48.6%) and Maldives (54.0%) have the higher prevalence. A telling example for the fast increase of obesity in the region is Malaysia where in 1996 only 21.0% of the population was recorded as overweight, but by 2015 this had more than doubled to 47.7% of all adults (Noor 2017).

The prevalence of overweight and obesity has remained high in the Pacific since 1990. Out of all the countries in this region, only Timor-Leste has a prevalence rate of less than 5%. In comparison, Tonga and Samoa have the highest rates at 86% and 84%, respectively. In Tonga more than half of male adults are obese. In Samoa over two thirds of women are obese. It is also worth mentioning that the increase in the overweight and obese population in the Pacific has stabilized over the years. Unlike the rapid growth in numbers that Asia is now experiencing, the growth in overweight and obesity rates in any of the Pacific countries was less than 20% from 1990 to 2013. However, the Pacific remains the world region by far the most affected by obesity. Such high obesity rates have tremendous public health implications. Another alarming trend is that childhood obesity has started to take on unseen dimensions. According to estimates published by The Lancet (2014), the number of overweight and obese children (below 20 years of age) was as high as 23% in the PRC and 22.5% in Malaysia.

While overweight and obesity have reach epidemic levels in Asia and the Pacific, it needs to be underscored that problems of malnutrition and undernutrition still exist in most countries. Children, especially in South Asia, continue to suffer from stunting and wasting. Countries in the region are thus faced with a double burden of overnutrition as well as malnutrition and undernutrition. While we recognize the importance of this issue, we focus in this paper solely on the problem of overweight and obesity.

2.4 Health Consequences of Overweight and Obesity

Overweight and obesity negatively affects body strength, lower body mobility, and daily activities (Jenkins 2004). Davidson et al. (2002) similarly observed that excess body weight and a BMI equivalent to 30 in older people causes physical dysfunction and increases the risk of future disability. Aside from physical limitations, overweight and obesity also increase the risks for several non-communicable diseases such as ischemic heart disease, hypertension, stroke, diabetes, and certain cancers.

About 70% of global deaths each year are caused by non-communicable diseases, where a majority of the deaths are related to cardiovascular diseases, followed by cancers, respiratory diseases, and diabetes (WHO, 2015). Coronary heart disease and stroke are the most common types of cardiovascular diseases - they killed 7.4 and 6.7 million individuals in 2012, respectively[2]. Previous studies (Singh et al., 2013; Wormser et al., 2011; Whitlock et al., 2009) showed that high BMI is an important factor for cardiovascular diseases. Lee et al. (2011) also observed that the risk of having a coronary heart disease or stroke is higher among overweight and obese individuals than among those with normal weight. Furthermore, they found that high BMI is highly associated with deaths from diabetes and certain types of cancer.

A recent review of more than a 1,000 studies by the International Agency for Research on Cancer (part of the WHO) found evidence that being overweight or obese increases the risk for at least 13 types of cancer (Lauby–Secretan et al. 2016). Type 2 diabetes has been recognized to be most directly related to overweight and obesity (e.g., Schmidt et al. 2013), including in Asia (e.g., Boffetta et al. 2011). Another well-documented health consequence is that obesity has been found to lower fertility, both of women (Moran 2011) and men (Sermondade et al. 2013). Overall, the WHO (2016) estimated that in 2013 an estimated 4.5 million deaths worldwide were attributable to overweight and obesity.

3. EXISTING COST-OF-ILLNESS STUDIES FOR ASIA

While the rapidly increasing prevalence of overweight and obesity in Asia and the Pacific region is becoming an alarming concern, the literature on estimating the equivalent economic cost remains fairly limited. In contrast, the costs of overweight and obesity have been very well documented for developed countries like the US or Europe (e.g., Lehnert et al. 2013; Konnopka et al. 2011; Yach et al. 2006; Allison et al. 1999; Wolf and Colditz 1998; Seidell 1995). In this section, we discuss several studies we found on Asia, namely on Japan; Republic of Korea; the People's Republic of China (PRC); Taipei,China; as well as Thailand.

We retrieved four previous cost-estimation studies on Japan that similarly utilized a population-based prospective cohort study. A prospective cohort study is done by administering a baseline survey at the beginning of the study period to gather information about the participants. These participants are then followed longitudinally (i.e., over a period of time) to track the changes in their exposure or health outcome. This approach is highly useful in analyzing the association between risk factors and medical outcomes. In the studies of Kuriyama et al. (2002), Kuriyama et al. (2004), Ohmori–Matsuda et al. (2007), and Nakamura et al. (2007), information about the health and lifestyles of the participants were gathered at the baseline. The medical

[2] Based on World Health Organization Fact Sheet, Reviewed September 2016. Accessed from http://www.who.int/mediacentre/factsheets/fs317/en/ on 21 April 2018.

utilization and cost for each participant are then monitored over several years, based on their claim history files of the Japanese National Health Insurance. Kuriyama et al. (2002), Kuriyama et al. (2004), and Ohmori–Matsuda et al. (2007) used the data from the survey of beneficiaries of the National Health Insurance aged 40–79 years in the Miyagi Prefecture, Japan, while Nakamura et al. (2007) used the data from the survey of beneficiaries of the National Health Insurance aged 40–69 years in the Shiga Prefecture, Japan. From these surveys, the monthly per person health care charges of different BMI categories were examined through analysis of covariance. Consistently, the four studies found that participants with BMI greater than 25 incur higher per person medical cost as compared with participants with lower BMI.

In addition, we obtained a number of other studies that estimated the economic burden of overweight and obesity in other parts of Asia. For instance, Zhao et al. (2008) estimated that the total direct annual cost of chronic diseases caused by overweight and obesity in the PRC amounted to US$2.74 billion in 2003. This is equivalent to 3.7% of the total national medical cost for that year. Likewise, Ko (2008) estimated both direct and indirect cost related to overweight and obesity in a representative district hospital in Hong Kong, China. He noted that the annual cost amounted to US$0.29 billion in 1998 and US$0.43 billion in 2002, which are equivalent to around 8.2% to 9.8% of the total public expenditure on health in Hong Kong, China. Both the studies by Zhao et al. (2008) and Ko (2008) utilized the population attributable fraction approach wherein the estimates reflect the extent to which a certain disease as well as the management cost related to that disease are attributable to a single factor.

Three other studies estimated the economic burden of obesity in Korean adults. Chung (2017) came up with an estimate of the direct cost while Lee et al. (2015) and Kang et al. (2011) estimated both the direct and indirect costs. Based on the study of Chung (2017), the direct cost of obesity amounted to 0.54 billion won in 2013. The estimate of Lee et al. (2015), which includes indirect cost, is relatively higher at 6.77 billion won. Comparatively, Kang et al. (2011) estimated the economic burden at US$1,787 million, which is about 3.7% of total health care expenditure. Similar to the studies of Zhao et al. (2008) and Ko (2008), Kang et al. (2011) also employed the population attributable fraction approach with the aid of nationally representative surveys such as the National Health Insurance Corporation cohort survey and the 2005 Korea National Health and Nutrition Examination Survey).

In a similar vein, Fu et al. (2008) estimated the direct cost of obesity in Taipei,China using individual data sourced from the Cardiovascular Disease Risk Factors Two-Township Study survey and utilization data from the Bureau of National Health Insurance of Taipei,China. This study likewise adopted the prevalence-based and population attributable risk approach for six kinds of obesity related metabolic syndrome diseases. The estimated cost of obesity amounted to about 2.9% of the national health care expenditure in Taipei,China. Correspondingly, Pitayatienanan et al. (2014) used the Obesity-Attributable Fraction in estimating the economic burden in Thailand. Aside from estimating the health care cost incurred by individuals, this study also estimated the cost of productivity loss due to premature mortality and the cost of productivity loss due to hospital-related absenteeism by adopting a human capital approach. The total cost of obesity in Thailand was estimated at US$725.3 million or about 1.5% of Thailand's national health expenditure and about 0.13% of its GDP. Moreover, it was noted that 54% of this cost can be attributed to the loss of productivity due to obesity.

4. ESTIMATING THE DIRECT COSTS OF OVERWEIGHT AND OBESITY

Aside from increasing the risk of several non-communicable diseases and other negative health consequences, overweight and obesity are also associated with high economic costs. In health economics, the economic costs are divided into two groups: direct and indirect costs. First, direct costs are all costs that are incurred for treating obesity-related illnesses. The direct costs can be further divided into medical costs (e.g., including doctor's fees, medicines, and medical operations) as well as nonmedical direct cost (e.g., transportation costs of the patient to the hospital). Indirect costs on the other hand capture the loss due to lower productivity or lesser quality of life of individuals as an effect of overweight and obesity. This cost can be related to disability or absenteeism in work. Section 4 explains the methodology used and the results obtained for the direct costs, while section 5 covers the indirect costs.

4.1 Estimating Direct Costs Across Countries

Standard Approaches to Estimate Direct Costs

The direct costs of overweight and obesity can be calculated in two ways. The first is called the epidemiological approach. It is based on the idea that overweight and obesity contribute to certain diseases and the treatment of these diseases generate medical costs. If we know the relative risk of an obesity-related disease (adjusted for other confounding factors) as well as the medical costs for the treatment of each disease, we can calculate the direct costs for the entire population. We simply multiply the overweight and obesity related disease burden with the disease-specific costs and sum up over all related diseases and the respective population. The data requirement for this approach, called population attributable fraction, is rather intensive. On one hand, we need to know the relative risks related to obesity and, on the other hand, the medical costs for all overweight and obesity related diseases. In almost all countries in Asia and the Pacific, data on disease specific medical costs are unavailable. This lack of data severely hampers the cost calculation not only for overweight and obesity, but for all non-communicable disease risk factors and for all diseases in general.

The second approach, which has become more popular in recent years, is an econometric approach (e.g., Finkelstein et al. 2009 or Cawley and Meyerhoefer 2012). The basic idea is that in a representative sample we try to measure the additional medical costs that overweight and obese people need to bear (controlling for possible confounding factors). In more technical language, we introduce a dummy variable for overweight and obese persons in the sample and then estimate their additional medical expenditures. In a final step we can extrapolate the costs for the entire population. The data requirements for this approach is less intensive compared to the first approach. Most importantly, a representative survey is needed that contains data on medical expenditures. Again, for developing Asia and the Pacific no comparable surveys across countries exist that would allow us to systematically estimate the cost across countries.

New Methodology to Estimate Direct Costs Across Countries

Due to lack of data we had to develop a methodology to estimate the direct costs across countries in a sound and robust way. The underlying idea of our approach

is to use the case of Japan as a baseline scenario. For the case of Japan, we have solid estimates for the direct costs of overweight and obesity. In a first step, we assume that overweight and obesity in other countries in Asia and the Pacific have similar costs. However, these costs need to be adjusted to the varying costs of drugs and medical services. We argue that GDP per capita is an appropriate way to adjust to different price levels across the region. Second, even when adjusted by the price level, countries in the region cannot afford to have the same total health care expenditures compared to Japan. We therefore also adjust for the total amount of health care expenditures.

Step 1: Use Direct Cost Estimates for Japan as Baseline

In Japan a number of detailed econometric studies have been undertaken to estimate the costs of overweight and obesity. We chose the four most recent studies for Japan and they are listed in Table 2. All papers for the case of Japan used nationally representative samples, analysis of adults of all ages, and the standard BMI cut-offs. All authors estimated either the additional expenditures per month or year. We therefore first annualized all costs and listed the costs in column three. As we can see, the cost estimates vary between 151,574 yen (Nakamura et al. 2007) to 342,240 yen (Ohmor–Matsuda et al. 2007). Such differences are not uncommon in this literature. For example, in the case of the US, the annual direct costs estimated by Finkelstein et al. (2009) are US$1,429, whereas Cawley and Meyerhoefer (2012) estimated them to be US$2,741.

Second, we adjusted the prices for each study (from reference year) to the 2013 price level using the consumer price index. Finally, we converted the price from Japanese yen into US dollars and calculated the average across all studies. The cost was US$2,654, which is very close to the amount for the US in the seminal paper by Cawley and Meyerhoefer (2012).

Table 2: Estimated Per Person Annual Cost of Overweight and Obesity in Japan

Reference	Year	Annual Cost (in ¥)	Reference Year	CPI Adjustment to 2013	¥ Equivalent in 2013	¥ to US$ Exchange Rate	US$ Equivalent in 2013
Kuriyama et al. 2002	1995 – 1998	300,744	1998	0.96	288,714	97.6	2,958
Kuriyama et al. 2004	1995 – 2001	264,672	2003	0.99	262,025	97.6	2,685
Nakamura et al. 2007	1991 – 2000	151,574	2006	0.99	150,059	97.6	1,538
Ohmori–Matsuda et al. 2007	1996 – 2001	342,240	2001	0.98	335,395	97.6	3,436
Mean							2,654

CPI = consumer price index.

Source: Authors.

Step 2: GDP Per Capita Adjustment of Health Care Costs

Medical costs vary considerably across countries for a variety of reasons. For many developing countries we only have anecdotal evidence of medical costs by diseases or medical procedures. However, since medical travel (patients traveling abroad to seek medical treatment) has become more widespread in recent years (Helble 2011), more and more data on prices for medical procedures have been published online. Table 3 lists the prices for two medical procedures—heart bypass and angioplasty, in seven Asian countries retrieved from various websites. Table 3: Comparative Prices of Medical Procedure in Asia

Medical Procedure	India	Rep. of Korea	Malaysia	Philippines	Singapore	Taipei,China	Thailand
Heart bypass[1]	7,900	26,000	12,100	11,500*	17,200	25,000[+]	15,000
Angioplasty[1]	5,700	17,700	8,000	–	13,400	6,000[+]	13,000

Notes: [1] Sourced from http://medicaltourism.com/Forms/price-comparison.aspx

* Sourced from http://www.health-tourism.com/philippines-medical-tourism/

[+] Sourced from Formosa Medical Travel.com; http://formosamedicaltravel.com/medical-tourism-blog/tag/hip-replacement-cost-comparison/

Source: Authors.

It should be noted that these prices typically do not reflect the costs incurred by domestic patients. Foreign patients are typically treated in private health care facilities where the price tends to be higher compared with public hospitals. Furthermore, the medical services included as well as the quality might vary across countries. But there clearly appears to be a correlation between the GDP per capita of a given country and the price offered for medical procedures. To test this hypothesis, we ran simple correlations between the GDP per capita and the price of the two medical procedures above (Table 4). We chose heart bypass and angioplasty as both interventions can be caused by overweight and obesity. The correlation between GDP per capita and the cost for heart bypass surgery is 0.51 and for angioplasty 0.46. We thus observe a clear relationship between GDP per capita and the cost of medical treatments. One can question the magnitude of the correlation, but in the absence of reliable cross-country data our approach yields a defendable estimate of the approximate medical costs.

Table 4: Correlations between GDP Per Capita and Price of Medical Procedures

	GDP Per Capita	Heart Bypass	Angioplasty
GDP Per Capita	1.000		
Heart Bypass	0.512	1.000	
Angioplasty	0.455	0.466	1.000

GDP = gross domestic product.

Source: Authors.

To obtain the additional health care expenditure due to overweight and obesity, we thus adjust the US$2,654 to the level of GDP of all Asia and the Pacific countries. For example, our estimations predict that a person suffering from overweight or obesity in India will face additional health care costs of US$101.86 per year. Using this simple approach, we are able to calculate an estimate of additional health care expenditures for all Asia and the Pacific countries.

Step 3: Adjustment to Total Health Care Expenditures

However, we argue that one additional adjustment is needed to obtain a more realistic cost estimate. One strong underlying assumption of the GDP per capita adjustment is that all patients across the region will have the possibility to have the same level of care as a Japanese patient. But in many developing countries access to health care is limited due to various factors, most importantly problems of affordability and access. For example, an obese Indian person typically does not have the same means or access to health care service compared to an obese Japanese person.

To account for the difference in affordability and access, we therefore propose to also adjust for the total health care expenditures of the country. The total health care expenditures are a proxy of a country's ability to cope with ill health of its citizens. In other words, they reflect the level of care that a country can afford.

In the second adjustment we calculate how much the total health care expenditures differ from Japan. We use the per capita health care expenditures of Japan as the benchmark and adjust for the other countries respectively. For example, in India the per capita health care expenditures are US$68.53 whereas in Japan they amount to US$3,960.20 In terms of the relative capacity to seek medical treatment, India can only offer around 1.73% of the Japanese level.

This again is a strong assumption. Some countries might offer a similar level of affordability and access compared to Japan at relatively lower costs. However, as long as we do not have empirical evidence to demonstrate the case, we need to rely on strong assumptions.

Overall, we thus adjust twice: first for the price differences for medical treatments and second for the difference in terms of affordability and access of health services. After the two adjustments we obtain a direct cost estimate for each overweight and obese person in all countries in our sample. In a last step, we simply multiply the number of overweight and obese population in each country with the estimated annual direct medical costs.

4.2 Results of Direct Cost Estimates

Our results from our direct cost estimation are shown in Table 5. In the first column we list the direct cost values while in the next two columns we compute how our estimates compare with each country's total health care expenditure and GDP, respectively.

In Central Asia, we observe that the direct cost of obesity is highest in Kazakhstan, followed by Azerbaijan and Turkmenistan. We note that these three countries also exhibited the highest prevalence of obesity in 2013 for this subregion. In addition, we find that the percentage of our direct cost estimates relative to each of these countries' total health care expenditure exceeded 7. The percentages of direct cost relative to their GDP are likewise high for these countries. Conversely, Tajikistan appears to spend the least on obesity.

Looking at the East Asia subregion, Japan appears to incur the highest direct cost due to obesity despite the relatively low prevalence rate of 23.3%, while the estimate for Mongolia appears to be smaller despite its high prevalence of obesity at 49.4% (see Table 1). In our estimation, we use Japan prices as our reference and practically assume that health care is more accessible in this country than in any other country in our sample (based on total healthcare expenditure). Hence, we expect that our direct cost estimate will also be high for countries such as Republic of Korea, which has a similar level of total health care expenditure as Japan.

India incurs the highest absolute direct cost for obesity in the South Asia subregion. But when we equate the estimated direct costs relative to the total health care cost of each country, Maldives overtakes India clearly with over 6%. The values are also high for Bhutan (1.51%) and Sri Lanka (1.45%). The rate of overweight and obesity for Maldives was at 40.3% in 2013, while for Sri Lanka and Bhutan it was 26.2% and 35.3%, respectively (see Table 1).

The Southeast Asia region is home to several countries that have experienced rapid increases in obesity rates from 1990 to 2013, such as Cambodia, Indonesia, the Philippines, and Thailand. Based on our estimates, Singapore, followed by Malaysia, incur the highest absolute direct costs for overweight and obesity. Equating our estimates relative to the total health care expenditure and GDP, we find that the highest percentages are observed in Singapore, Brunei, and Malaysia. The prevalence of obesity in Malaysia in 2013 was the highest in the region at 46.3%, followed by Singapore at 38.2% (see Table 1).

Table 5: Direct Cost Estimates of Overweight and Obesity

	Direct Cost		
Country	Value	% of Total Health Care	% of GDP
Central Asia			
Armenia	17,400,000	3.45	0.16
Azerbaijan	364,000,000	8.95	0.50
Georgia	55,600,000	4.75	0.34
Kazakhstan	1,410,000,000	13.40	0.58
Kyrgyz Republic	5,434,683	1.11	0.07
Tajikistan	4,248,632	0.74	0.05
Turkmenistan	65,100,000	7.39	0.16
Uzbekistan	54,700,000	1.51	0.10
East Asia			
PRC	17,900,000,000	3.44	0.19
Korea, Rep. of	13,600,000,000	14.40	1.04
Japan	77,900,000,000	15.47	1.59
Mongolia	19,600,000	3.70	0.16
Taipei,China	–	–	–
South Asia			
Afghanistan	8,719,833	0.53	0.04
Bangladesh	14,200,000	0.30	0.01
Bhutan	1,070,865	1.51	0.06
India	443,000,000	0.53	0.02
Maldives	19,000,000	6.09	0.68
Nepal	1,724,662	0.16	0.01
Pakistan	44,700,000	0.71	0.02
Sri Lanka	35,800,000	1.45	0.05

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Table 5 *continued*

Country	Direct Cost		
	Value	% of Total Health Care	% of GDP
Southeast Asia			
Brunei	76,900,000	16.27	0.43
Cambodia	2,415,455	0.27	0.02
Indonesia	450,000,000	1.68	0.05
Lao PDR	1,429,996	0.66	0.01
Malaysia	1,090,000,000	8.40	0.34
Myanmar	5,002,899	0.39	0.01
Philippines	145,000,000	1.17	0.05
Singapore	5,050,000,000	37.18	1.68
Thailand	640,000,000	3.80	0.15
Viet Nam	53,500,000	0.44	0.03
The Pacific			
Fiji	7,575,501	4.24	0.18
Papua New Guinea	21,500,000	2.13	0.10
Solomon Islands	1,339,303	2.22	0.12
Timor-Leste	310,128	0.43	0.01
Vanuatu	852,050	2.71	0.11
Palau	2,375,833	11.20	1.04
Marshall Islands	1,529,137	4.67	0.80
Micronesia	1,672,560	3.95	0.53
Samoa	3,396,783	6.15	0.43
Tonga	1,449,878	6.52	0.33
Kiribati	450,269	2.36	0.24

GDP = gross domestic product; PRC = People's Republic of China.

Source: Authors.

The results for the Pacific are particularly interesting. While obesity rates in this subregion are some of the highest in the world, our estimated direct costs appear to be smaller than those of other countries in different subregions. We attribute this to the fact that we used Japan as a benchmark, where we utilized the total health care expenditure of each country relative to Japan as an indicator of access to health care. We therefore expect that the direct cost of obesity would increase tremendously if the people of the countries in this region had the same level of access to health care as in Japan.

Within the Pacific subregion, Papua New Guinea yields the highest value of direct cost. However, relative to each country's total healthcare expenditure and GDP, Palau appears to incur the highest cost on overweight and obesity. Shares of direct costs in total healthcare expenditure are also high in Tonga and Samoa while shares of direct cost in GDP are high in the Marshall Islands and Micronesia.

5. ESTIMATING THE INDIRECT COST OF OVERWEIGHT AND OBESITY

5.1 Estimation Strategy

Our strategy for estimating the indirect cost of overweight and obesity in Asia and the Pacific is largely based on the disability-adjusted life year (DALY) metric from the 2010 Global Burden of Disease (GBD) study. The DALY is a measure that incorporates the years of life lost due to premature death (mortality) as well as the years of life lost due to disability (morbidity) (see also WHO 2017). The DALY is an extension of the concept of potential years of life lost due to premature death (PYLL) as it includes the years of "healthy" life lost due to disability or sickness. A unit of DALY represents a year's loss of healthy life. On the other hand, the measured disease burden shows the disparity between a population's health status and a healthy population standard.

The DALY for a disease or health condition is calculated as the sum of the years of life lost due to premature mortality (YLL) in the population and the equivalent "healthy" years lost due to disability (YLD) for incident cases of the health condition:

$$DALY = YLL + YLD$$

The YLL component is determined by comparing age at death with the expected life expectancy of the respective country, including several adjustment factors. The discount rate (r) used in the DALY is 3% to reflect how health is valued in the future. Additionally, the age-weighting adjustment factors are incorporated to account for the years of healthy life lived at different ages.

$$YLL_i = \frac{KC_e^{ra}}{(r+\beta r)^2}\, x\, [e^{-(\beta+r)(L+a)}\, x\, (r+\beta r)\, x\, \big((L+a)-1\big) - e^{-(r+\beta r)a}\, x\, \Big(\big(-(r+\beta r)(a-1)\big)\Big] + \left[\left(\frac{1-K}{r}\right)(1-e^{-rL})\right]$$

where:

$r =$ discount rate $(r = 0.03)$

$C =$ age-weighting correction constant $(C = 1)$

$\beta =$ parameter from the age-weighting function

$K =$ age-weighting modulation factor

$a =$ age of death

$L =$ standard expectation of life at age a

The YLD component on the other hand, is the product of number of incident cases of disease, duration of each case, several adjustment factors, and a disability weight that reflects the degree of disability. The disability weights quantify societal preferences for different health states. These weights do not represent the lived experience of any disability or health state, or imply any societal value of the person in a disability or health state. Rather, they quantify societal preferences for health states in relation to the societal "ideal" of optimal health.

$$YLD_i = D\left\{\frac{KCe^{ra}}{(r+\beta)^2}x\left[e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1]-e^{-(r+\beta)a}[-(r+\beta)a-1]\right]+\frac{1-K}{r}(1-e^{-rL})\right\}$$

where:

$a =$ age at the onset of disability

$L =$ duration of disability

$r =$ discount rate $(r = 0.03)$

$\beta =$ age-weighting parameter

$K =$ age-weighting modulation factor

$C =$ age-weighting correction constant

Our DALY estimation includes eight types of disease attributable to high BMI: (1) ischemic heart disease, (2) stroke, (3) diabetes, (4) liver cancer, (5) breast cancer, (6) esophagus cancer, (7) gall bladder and biliary tract cancer, and (8) hypertensive heart disease. The contribution of each of these diseases to the DALY is presented in Table 6. None of these diseases is fully attributable to high BMI, however. For instance, ischemic heart disease is also caused by other factors such as age, stress, family history, smoking, or diabetes. Hence, the DALY estimation adjusts for the real contribution of overweight and obesity to each of these diseases, which is specified in the last column.

Table 6: Disease Attributable to Overweight and Obesity

	Disease	Risk Factor Attribution (%)	Proportion from Total DALY (%)	Real Contribution of BMI>=25 to DALY (%)
1	Ischemic heart disease	15.63	6.76	1.06
2	Stroke	19.56	8.73	1.71
3	Diabetes	40.99	3.19	1.31
4	Liver cancer	9.99	2.26	0.23
5	Breast cancer	11.86	0.54	0.06
6	Esophagus cancer	14.59	0.86	0.13
7	Gall bladder and Biliary tract cancer	11.28	0.15	0.02
8	Hypertensive heart disease	29.83	0.96	0.29
Total				**4.79**

DALY = disability-adjusted life year; BMI = body mass index.

Source: Institute for Health Metrics and Evaluation.

The DALY estimates for Asia and the Pacific countries are shown in Table 7. We observe that countries with high prevalence of overweight and obesity also lose more productive years as a consequence. This is also expected to result in a high economic burden.

Table 7: DALY Estimates for Asia and the Pacific

		DALY for All Diseases	Real Contribution of Overweight and Obesity (%)	Total Productive Years Lost Due to Overweight and Obesity
1	Afghanistan	18,539,562	1.33	247,063
2	Armenia	895,647	0.95	8,553
3	Azerbaijan	2,759,950	1.14	31,363
4	Bangladesh	50,765,824	0.36	184,439
5	Bhutan	240,620	0.54	1,296
6	Brunei	72,185	0.81	585
7	Cambodia	5,736,940	0.31	17,795
8	PRC	337,486,044	1.37	4,625,049
9	Fiji	328,420	1.88	6,188
10	Georgia	1,563,220	0.74	11,583
11	India	494,698,971	0.36	1,771,258
12	Indonesia	72,340,657	1.05	756,612
13	Japan	32,107,323	0.16	51,332
14	Kazakhstan	6,106,554	0.99	60,653
15	Kiribati	45,852	2.00	916
16	Republic of Korea	11,293,720	0.29	33,247
17	Kyrgyz Rep.	1,768,906	0.93	16,477
18	Lao PDR	2,635,899	0.42	11,002
19	Malaysia	63,836,217	0.09	59,586
20	Maldives	60,800	0.57	347
21	Marshall Islands	24,810	2.09	518
22	Micronesia	31,031	1.52	472
23	Mongolia	1,101,810	1.15	12,695
24	Myanmar	19,078,657	0.52	99,270
25	Nepal	8,319,695	0.42	35,005
26	Pakistan	77,324,260	0.75	579,995
27	Palau	78,298	1.43	1,117
28	Papua New Guinea	3,494,152	1.02	35,542
29	Philippines	28,205,496	0.73	204,948
30	Samoa	45,827	2.55	1,167
31	Singapore	763,405	0.50	3,852
32	Solomon Islands	193,819	2.64	5,118
33	Sri Lanka	5,223,416	0.49	25,453
34	Taipei,China	5,618,176	0.50	28,264
35	Tajikistan	2,569,464	0.60	15,362
36	Thailand	19,075,344	0.47	89,665
37	Timor-Leste	326,080	0.22	718
38	Tonga	29,768	1.81	537
39	Turkmenistan	1,837,222	1.21	22,206
40	Uzbekistan	8,763,864	1.32	115,573
41	Vanuatu	91,298	1.97	1,801
42	Viet Nam	21,840,038	0.27	58,439

DALY = disability-adjusted life year; PRC = People's Republic of China.

Source: Institute for Health Metrics and Evaluation.

To generate a monetary equivalent of the productive years lost from the DALY estimation, we multiply the figures in Table 7 with the per capita income in each of our country samples. As previously mentioned, a unit of DALY is equivalent to a loss of one year of healthy life. Thus, we equate this loss to the potential average annual earnings in each individual country and consider this to be the indirect cost of overweight and obesity.

5.2 Results of Indirect Cost Estimates

Table 8 shows a detailed table on the indirect costs of overweight and obesity in Asia and the Pacific. Based on our estimates, countries such as Turkmenistan, Mongolia, Nepal, Afghanistan and Indonesia with high rates of overweight and obesity (see Table 1), suffer from high economic losses because of lower productivity.

Table 8: Indirect Costs of Overweight and Obesity in Asia and the Pacific
(in US dollars)

	Indirect		
Country	**Value**	**% of Total Healthcare**	**% of GDP**
Central Asia			
Armenia	31,900,000	6.31	0.29
Azerbaijan	249,000,000	6.11	0.34
Georgia	49,400,000	4.22	0.31
Kazakhstan	861,000,000	8.21	0.35
Kyrgyz Republic	20,900,000	4.27	0.29
Tajikistan	16,100,000	2.80	0.19
Turkmenistan	176,000,000	19.98	0.42
Uzbekistan	218,000,000	6.05	0.38
East Asia			
PRC	32,700,000,000	6.31	0.34
Korea, Rep.	864,000,000	0.92	0.07
Japan	1,980,000,000	0.39	0.04
Mongolia	55,400,000	10.46	0.44
Taipei,China	619,000,000	–	0.12
South Asia			
Afghanistan	163,000,000	9.94	0.81
Bangladesh	190,000,000	4.09	0.12
Bhutan	3,177,009	4.49	0.17
India	2,620,000,000	3.11	0.14
Maldives	2,875,898	0.92	0.10
Nepal	24,200,000	2.21	0.13
Pakistan	731,000,000	11.70	0.32
Sri Lanka	82,300,000	3.32	0.12

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Table 8 *continued*

Country	Indirect		
	Value	% of Total Healthcare	% of GDP
Southeast Asia			
Brunei	26,100,000	5.51	0.14
Cambodia	18,000,000	1.99	0.12
Indonesia	2,780,000,000	10.39	0.30
Lao PDR	17,500,000	8.13	0.16
Malaysia	638,000,000	4.91	0.20
Myanmar	117,000,000	9.02	0.19
Philippines	567,000,000	4.58	0.21
Singapore	214,000,000	1.58	0.07
Thailand	551,000,000	3.28	0.13
Viet Nam	111,000,000	0.91	0.06
The Pacific			
Fiji	29,500,000	16.49	0.70
Papua New Guinea	102,000,000	10.12	0.48
Solomon Islands	10,100,000	16.79	0.91
Timor-Leste	3,598,982	4.96	0.06
Vanuatu	5,627,507	17.90	0.70
Palau	14,600,000	68.66	6.36
Marshall Islands	1,839,202	5.62	0.97
Micronesia	1,438,419	3.40	0.46
Samoa	4,897,133	8.87	0.61
Tonga	2,312,910	10.40	0.52
Kiribati	1,571,820	8.23	0.84

Source: Authors.

The summary of our results from the direct and indirect cost estimation is presented in Table 9. We used different strategies to estimate the direct cost and indirect cost related to overweight and obesity, and accordingly the resulting figures are very different. Our direct cost estimation is based on the estimates from three studies that utilized a model-based approach in computing the annual per capita health-care spending of normal-weight and overweight/obese adults, with the aid of nationally representative surveys. Our indirect cost estimation on the other hand, is based on the DALY estimates that incorporate the risk factor attribution of overweight and obesity on the eight diseases we identified.

Based on our estimates, the direct cost of overweight and obesity in Asia and the Pacific equates to about 0.56 %t of the combined GDP in this region while the indirect cost is about 0.22 %. A closer evaluation of our estimates reveal that the direct cost of overweight and obesity is heavily affecting the East Asia, Central Asia and Southeast Asia regions. On the other hand, the indirect cost of overweight and obesity is a heavy burden for the Pacific and Central Asia regions.

Table 9: Estimated Cost of Overweight and Obesity by ADB Region
(in million US$)

	Mean Direct Cost			Mean Indirect Cost		
	Value	% of Total Healthcare Expenditure	% of GDP	Value	% of Total Healthcare Expenditure	% of GDP
Central Asia	247	9.08	0.43	203	7.46	0.35
East Asia	27,300	9.78	0.69	8,910	3.19	0.22
South Asia	71	0.56	0.02	477	3.79	0.16
Southeast Asia	751	7.69	0.30	504	5.16	0.20
The Pacific	4	2.74	0.12	16	11.49	0.51
Total	**2,910**	**8.90**	**0.56**	**1,130**	**3.46**	**0.22**

ADB = Asian Development Bank; GDP = gross domestic product.
Source: Authors.

6. SUMMARY AND CONCLUSION

This paper constitutes a primer in terms of estimating the costs of overweight and obesity across the Asia and the Pacific region. Due to a severe shortage of necessary data, our estimations rely of several assumptions. This caveat needs to be taken into account when analyzing our numbers. Overall, we estimate a burden of 12.36% of health care expenditure and 0.78% of GDP. In terms of direct costs, we estimate that overweight and obesity contribute to about 8.9% of health care expenditure. The subregion with the lowest costs is South Asia with 0.56%, while East Asia faces the highest costs with 9.78% of health expenditure. The low direct costs of South Asia are not an indication that overweight and obesity are a minor issue; rather, it is due to the fact that the health systems in these countries only provide a fraction of the health care that would actually be needed. Millions of overweight and obese who suffer from related diseases are thus either not treated or undertreated. As the health care systems in the region will be improving along with economic growth, we expect that the share of non- or undertreated patients will decline. If the prevalence of overweight and obesity remains high or even increases, it will increasingly absorb the health expenditure.

As for the indirect costs, we estimate that the two regions currently most affected by the problem—Central Asia and the Pacific—will suffer most. The model for indirect costs yields the lowest estimates for East Asia, the main reason being that life expectancy is still relatively high in almost all countries of this subregion. Diseases that can be caused by overweight and obesity take away life prematurely, though to a lesser extent than in regions with lower life expectancies. Since we know that childhood obesity has sharply increased in several countries in East Asia, there is a risk that life expectancy will also be affected in the long run. Interventions to curb the rising trend in obesity are urgent. Unless swift action is taken, overweight and obesity risk undermining the economic development of the entire region.

Overweight and obesity are public health problems that can basically be tackled on two fronts:[3] nutritional intake and physical activity. Improving nutritional intake can be more difficult than may be expected. Food choices are a mix of cultural, societal factors and market related factors, mainly in terms of availability and price. One approach is to

[3] Drugs for weight reduction have been proven to lower the weight only marginally and need to be accompanied by life style interventions (Yanovski et al. 2014).

ensure that school food is healthy and provides students with an example of healthy food choices. Influencing the food choice of children is the approach that has been focused on in various countries. Another approach is to regulate marketing of unhealthy foods. Aggressive television marketing has been identified as playing an important role in influencing the food choices of consumers, including those of children (Desrochers and Holt 2007). Several countries have therefore imposed restrictions on the marketing of certain foods to children. Introducing food labels that allow consumers to make better-informed decisions is another option. Taxes on unhealthy foods, such as sugar, can help to steer the consumer towards more healthy food; however, taxes alone might not be enough.

A first entry point to encourage physical activity can be the school again. Sports should be an integral part of the curriculum of each student at every grade. Furthermore, physical activity can be encouraged by appropriate urban planning. Cities with a dense network of public transportation as well as sidewalks provide incentives for citizens to walk instead of taking cars. Urban planners should also include parks and similar amenities that encourage physical activities.

One might ask the question about the cost-effectiveness of these interventions. The costs of the intervention certainly vary substantially. For example, regulations to restrict marketing to children have relatively low costs and possibly a high effectiveness. Food labeling requirements can impose substantial costs on producers. And if badly designed, food labels, rather than leading better food choices, may confuse the consumer. Programs to improve school food may impose a substantial burden on schools already operating on tight budgets. Making the urban landscape conducive to physical activity can also be costly. Considerations about physical activity should be taken into account at the planning stage. Later changes to the urban landscape to encourage physical activity can also be very expensive. More research in the area of cost-effectiveness is certainly warranted. Especially for developing countries it would be important to know which interventions are most cost-efficient. However, it may not always be straightforward to gauge the costs of certain interventions and even more so their effectiveness.

Another important area of action concerns the health care system itself. Overweight and obesity are often noticed by health care workers, but are typically not well responded to. Health care professionals tend to be trained in curative health services, but not in weight management. In developing countries overweight people go to primary care centers for co-morbidities, not for weight management. Another obstacle can be that health care facilities are ill-equipped to receive obese patients. Hospital infrastructure needs to be upgraded to handle obese patients.[4]

New technologies are often blamed for contributing to the obesity problem. Public health experts are especially worried about the fact that the time spent in front of screens, especially smart phone screens, has increased in recent years, which typically means lower levels of physical activity. New technologies may worsen the obesity problem, but we should also think about how to actively use them to fight the pandemic. For example, smartphones can be useful tools for monitoring physical activity, e.g., to count steps. They may also be used to actively encourage physical activity. Games, such as Pokemon Go, have been found to increase the number of steps, but without any lasting effect (Howse et al. 2016). One could also imagine that smartphone are connected to scales and thus help to monitor body weight. Another scenario for the future could be that smartphones help to track and monitor food intake.

[4] For example, in Malaysia currently only one hospital is able to receive obese patients weighing more than 250 kg.

Finally, when analyzing interventions it should be kept in mind that although the problem of excess body weight has received tremendous public attention in recent years, no country in the world has succeeded in implementing a successful policy intervention to curb the increasing number of overweight and obese individuals for the past 33 years.[5] The rapid increase in the worldwide prevalence of overweight and obesity has thus become an ever more pressing global health issue. For the case of Asia, this paper provides the first costs estimates. We find that due to the increased risk of several non-communicable diseases, higher morbidity and mortality due to excess body weight already impose a heavy financial burden throughout the region. The size of the problem poses serious risks for human and economic development in many countries. Hence, urgent action is needed to ensure that Asians become fit and healthy.

[5] As discussed in Institute for Health Metrics and Evaluation Report, accessed from http://www.healthdata.org/news-release/nearly-one-third-world%E2%80%99s-population-obese-or-overweight-new-data-show (accessed 1 May 2017.

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