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Estimation of Cancer Incidence and Mortality Attributable to Overweight, Obesity, and Physical Inactivity in China

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Abstract

The Objectives was to provide an evidence-based, systematic assessment of the burden of cancer due to overweight/obesity and physical inactivity in China. This study evaluated the proportion of cancers of colon, rectum, pancreas, breast (postmenopausal), endometrium and kidney attributable to overweight (30 kg/m^2>BMI≥25 kg/m^2)/obesity (BMI≥30 kg/m^2) and physical inactivity in China in 2005. Data of prevalence of overweight/obesity, and lack of physical activity were derived from cross-sectional surveys among representative samples of Chinese population, and data of relative risks on cancers were derived from meta-analyses or large-scale studies from China and East Asian populations. The attributable fractions were calculated by combining both data of prevalence and relative risks. In China in 2005, 0.32% of cancer deaths and 0.65% of cancer cases were attributable to overweight and obesity combined. Lack of physical activity was responsible for 0.27% of cancer deaths and 0.39% of cancer cases. Future projections indicate that the contribution of overweight and obesity to the overall cancer burden will increase in the next decades. The largest increased attributable fractions will be for endometrial cancer. The increase in attributable fractions would be greater in men and in rural populations. Although the current burden of cancer associated with overweight/obesity and physical inactivity is still relatively small in China, it is expected to increase in the future.

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Keywords

overweight; obesity; BMI; physical inactivity; cancer; attributable fraction; China

INTRODUCTION

Overweight and obesity due to sedentary lifestyle and excess energy intake have emerged as a major health problem in many countries, including China. In 2005, there were an estimated 1.6 billion overweight adults worldwide, of whom 400 million were obese [1]. Frequent physical activity is an important behavior for individual and population health, with possible benefits such as prevent unhealthy weight gain [2]. The 2002 World Health Report on "Reducing Risks, Promoting Healthy Living" stated that overall physical inactivity was estimated to cause 1.9 million deaths (in 2000) and 19 million disability adjusted life year losses annually, as well as about 15–20% of cases of ischemic heart disease, diabetes and some cancers [3]. The World Health Organization (WHO) estimates that at least 60% of the world's population fails to meet the recommended daily level of physical activity [4].

During the past 3 decades, China has experienced a tremendous socioeconomic development, as well as significant lifestyle changes, particular in the urban population. Although the current prevalence of obesity and physical inactivity in China is relatively low compared with many high-income countries, some of the adverse behavior changes, such as excessive intake of dietary fat and sedentary lifestyle, have posed a major risk for some serious chronic diseases, such as type 2 diabetes, cardiovascular disease, hypertension, and certain types of cancer [5].

Cancer has become one of the major causes of deaths in China, accounting for one-fifth of total deaths in 2005 [6]. Obesity and physical inactivity have been established as independent risk factors for the following cancers: pancreas, colorectum, breast (postmenopausal), endometrium, and kidney, as well as adenocarcinoma of the esophagus [7]. Yet a comprehensive estimate of the cancer burden attributable to overweight, obesity, and physical inactivity in China is lacking. Therefore, we calculated the contribution of obesity and physical inactivity to the burden of these cancers in China in 2005 and provided future projection based on the current epidemiological trend. Such information is crucial for the future development of cancer prevention and control strategies.

This research was part of a project conducted by the Cancer Institute of Chinese Academy of Medical Sciences aimed at providing evidence-based estimates of the numbers of cancer deaths and new cancer cases in China which can be attributable to known risk factors, including smoking [8], alcohol drinking [9], occupational exposures, nutritional, and anthropometric factors. Presented herein are results on the contribution of overweight, obesity, and physical inactivity to the burden of specific cancers in China in 2005 by combining both prevalence and relative risk data based on results derived from existing studies.

MATERIALS AND METHODS

Methods for Study

The proportion of cancer in the total population that can be attributable to a risk factor is defined as attributable fraction (AF) and expressed as a percentage [10]. For risk factors expressed as dichotomous variables, the calculation of AF depends on 2 variables, the relative risk (RR) of a risk factor to a specific cancer, and the prevalence (P) of the exposure in the total population [11].

Data Selection

A search was conducted on Pubmed, MEDLINE, Google Scholar and China National Knowledge Infrastructure (CNKI) for all publications in English and Chinese. A combination of text search terms was used: overweight, obesity, BMI, physical activity/ inactivity, exercise, colon/rectum/pancreas/kidney/breast/ endometrium cancer, with Chinese and other East Asian populations as the main targets. A latency time of 10–15 years was selected between exposure and cancer occurrence as per current standards [12]. Therefore, we considered exposures occurring around 1990. Hence the inclusion criteria were set as the following: 1) data obtained in recent 10–15 yr; 2) data containing RR or odds ratio and corresponding 95% confidence intervals; 3) meta-analysis or large-scale surveys of representative samples of China were given the highest priority, followed by non-representative samples of China, or meta-analysis from Asian or Western countries; and 4) a definition of RRs of body mass index (BMI), physical inactivity and cancers is consistent with our study. AFs were calculated for urban and for rural populations separately because of differences in the prevalence of these 2 factors between urban and rural areas.

Overweight and Obesity

Definition of exposure—The body mass index (BMI) is one of the most commonly used weight-based measures to assess the health effects of excess bodyweight. It is expressed as the weight divided by the square of the height (kg/m^2) of an individual. WHO recommends the following criteria of BMI cut-offs for international comparisons: a BMI equal to or above 25 is regarded as “overweight”, whereas a BMI equal to or greater than 30 is graded as “obesity” [13].

Data used for RR estimates—RR estimates of breast (postmenopausal) and endometrial cancer were calculated based on data from the Shanghai Women’s Health Study (SWHS) [14]. This prospective, population-based, cohort study took place in urban Shanghai, including a total of 74,942 Chinese women aged 40–70 yr. However, because RR estimates for other cancers were not available from Chinese studies, and could not be calculated based on the data from the SWHS because of the small number of events, we used RR estimates from studies conducted in other countries in East Asia. The most informative study, from which we abstracted the RR for cancers of pancreas, rectum, colon (men only), and kidney (men only) was the Korean Cancer Prevention Study (KCPS), a prospective cohort study analyzing BMI and cancer incidence in over 1 million Koreans [15].

RRs used in the article are reported in Table 1. RR estimates for adenocarcinoma of the esophagus in men and women were not available; RR estimates for colon and kidney cancer in women from Asian studies suggest no association and were therefore excluded.

Data used for estimating prevalence of exposures—Prevalence estimates of overweight and obesity were extracted from the 1992 China National Nutrition Survey [16]. Anthropometric data of 82,538 individuals were collected across the nation in 1992. Body height and weight data were assessed by residence and gender in the age group of 20 to 45 yr among Chinese young adults. Data from 3 municipalities (Beijing, Tianjin and Shanghai) were excluded because the mean BMI of the 3 cities was higher in comparison with the nationwide results. In all, overweight and obesity were more prevalent in women and in an urban population, compared with their counterparts (Table 2).

Estimates of future AF—An increasing trend of overweight and obesity has been observed in China in recent years. [17, 18] Therefore, it is conceivable that the fractions of cancers due to overweight and obesity will increase significantly in the future. Assuming that the RR for obesity-related cancers remained stable and that the effect of body mass on cancer risk occurs with a 10–20 yr latency, we projected the AF estimates of overweight and obesity of cancers in 2015, based on the prevalence data collected in a 2002 survey similar to the one conducted in 1992 [19] (Table 2).

Physical Inactivity

Definition of exposures—The World Cancer Research Fund and American Institute for Cancer Research (WCRF/AICR) review concluded that adequate physical activity protects against colon cancer as an independent risk factor. Conversely, physical inactivity is an independent risk factor for colon cancer [7]. Participating in 30 min or more of moderate to vigorous activity daily constitutes being physically active [4].

Data used for RR estimates—No adequate results on the RR of colon cancer associated with lack of physical activity were available from Chinese studies. Therefore, we used the RR of colon cancer associated with occupational and leisure-time physical activity derived from a recent meta-analysis of 19 cohort studies [20]. Given the heterogeneity within which physical activity was measured in the studies included in the meta-analysis, the authors presented pooled estimates of RRs with colon cancer in males (0.71) and females (0.87), using fixed analyses, regardless of physical activity type. We used the reverse of these estimates (RR=1.42 in men and RR=1.15 in women) as the risk of colon cancer for lack of adequate physical activity.

Data used for Prevalence—No data on the prevalence of physical inactivity in the 1990s in China were available for our analysis. Therefore we extracted prevalence data from the InterASIA study (International Collaborative Study of Cardiovascular Disease in Asia) conducted in China and other Asian countries between 2000 and 2001[21]. A total of 14,933 participants aged 35 to 74 yr completed the survey questionnaire. To the best of knowledge, this is the first study providing nationally representative data regarding the prevalence of physical inactivity. Findings indicated that women and urban residents were less physically active (Table 2).

Cancer Mortality and Incidence Data

Data on cancer mortality in China in 2005 were derived from The Third National Death Cause Survey, a retrospective survey conducted in 160 randomly selected counties and 53 high-risk areas between 2004 and 2005. A total of 142,660,482 person-yr were covered, including 24,300,984 person-yr from urban male, 23,598,822 person-yr from urban female, 48,669,257 person-yr from rural male, and 46,091,419 from rural female. Cancer incidence data were estimated using Mortality and Incidence (M/I) ratio and cancer deaths. Detailed description of data collection and simulation is published elsewhere [22]. Table 3 reports the number of cancer deaths and cases in China in 2005 by urban/rural residence and gender.

Statistical Analysis

We used the formula proposed by Levin for AF calculation [11].

$$AF=\frac{P\times(RR-1)}{P\times(RR-1)+1}$$

AF is attributable fraction. RR is relative risk of a risk factor and specific cancer, and P is the prevalence of exposure to the risk factor in the total population. The scenarios chosen for calculation of AF to overweight/obesity and to physical inactivity were that of attainable frequency, level or intensity of the exposures (i.e., all individuals with BMI<25 or adequate level of physical activity) [23]. Particularly, for the calculation of AF to BMI, the prevalence for overweight referred to people with a BMI between 25 kg/m^2 and 29 kg/m^2, and the prevalence for obesity referred to people with a BMI equal to, or above 30 kg/m^2. The overall $AF_{BMI\geq25\ kg/m^2}$ (overweight and obesity combined) was calculated by adding $AF_{25<BMI<30\ kg/m^2}$ and $AF_{BMI>=30\ kg/m^2}$ together.

The numbers of deaths and cases of a specific cancer attributable to overweight/obesity or physical inactivity were calculated by applying the estimated AF to the corresponding figures in Table 3. The percentages of contribution of overweight/obesity and physical inactivity to the burden of specific cancers (colon, rectum, pancreas, breast in post menopausal, endometrium and kidney) were then calculated.

RESULTS

Calculations of attributable fractions of overweight and obesity for cancer deaths and new cancer cases by residence and gender are summarized in Table 4. In all, overweight and obesity were responsible for 5,782 cancer deaths (0.32% of all) and 16,861 cancer cases (0.65% of all) in China in 2005. Our findings suggested excessive body weight played a relatively bigger role in women and in urban population. Overweight and obesity were involved in a large proportion in hormone-related women cancers, particularly for endometrial cancer.

Fig. 1 and 2 show how the increase of prevalence of overweight and obesity from 1992 to 2002 will affect the AF estimation of cancer burden in China in 2015. A rapid increase of AF estimates was observed at all included cancer sites. The largest increased was noted for endometrial cancer for both areas. In urban women from 2005 to 2015, AF for endometrial cancer would increase from 18.9% to 30.4%, followed by breast cancer (postmenopausal) (from 8.8% to 11.9%). The relative increase in AF would be greater in men and rural populations. An approximately 2-fold increase was observed in AFs for cancers of colon (0.63% to 1.83%), rectum (0.29% to 0.83%), pancreases (0.49% to 1.42%) and kidney (0.77% to 2.15%) in rural men population from 2005 to 2015. Calculations of attributable fractions of physical inactivity for colon cancer deaths and cases are summarized in Table 5. In all, an estimated 4,863 cancer deaths (0.27% of all cancer deaths) and 10,293 cancer cases (0.39% of all cases) were attributed to physical inactivity in China in 2005. Physical inactivity had greater influence in men and in urban residents.

DISCUSSION

This is the first study aimed at systematically assessing the proportion of cancers attributable to overweight, obesity and physical inactivity in China. According to our estimation, a total of 5,782 cancer deaths (0.32%) and 16,861 cancer cases (0.65%) were attributable to overweight and obesity in 2005. AFs were higher in women and in urban population. At the same time, lack of physical activity was responsible for 4,863 deaths and 10,293 new cases of colon cancer nationwide, representing 0.27% and 0.39% of the total cancer burden, respectively. Our study showed that contributions of overweight, obesity, and lack of physical activity were relatively small compared to the current cancer burden in China. Nevertheless, results were likely to be underestimated based on the following arguments.

For the estimation of AF to overweight and obesity, several cancer sites were excluded from our calculation because the role of BMI in these cancers has not been fully explored in Asian populations: (1) adenocarcinoma of the esophagus being consistently associated with increased BMI among European and American populations; however, this was not the main histological type of esophageal cancer in China and neighboring countries, and there was a lack of adequate studies on this type of cancer [14, 15]; and (2) we found that results on the association between BMI and cancers of the colon and kidney were not consistent in Asian women. Both the KCPS and SWHS cohorts showed negative or null associations of colon cancer and kidney cancer with BMI in women. Table 6 summarizes the findings from other Asian studies [24, 25, 26]. Given the high level of heterogeneity in the study designs and BMI cut-offs, no attempt at estimating overall quantitative synthesis combining data across studies was made.

A possible explanation for the inconsistency in those findings was that menopausal hormone therapy or other hormonal factors modulate the association between BMI and cancer and the distribution of the frequency of use of these hormonal factors was lower in Asia compared to Europe and North America [26]. As the debate remained controversial, it seemed prudent for us not to calculate a BMI AF for these cancer sites in women. Besides, we excluded data from 3 large municipalities with higher BMI means, which might also lead to underestimation of AF. For the estimation of AF to physical inactivity, only colon cancer was included based on the recommendation in the WCRF/AICR Report [7]. However, this report also mentions that physical inactivity may play a suspected role in some hormone-related cancers in women as well. There were only a few studies investigating the association between physical inactivity and cancers of the breast, ovary, and endometrium among Chinese women [27, 28, 29]. Yet the difference in the approaches used during data collection and analysis might challenge the validity and comparability of their findings. In addition, prevalence estimates on physical inactivity in China were based on survey questionnaires rather than accurate measurements, which might not be a strong source of precise data.

Given the fact that several cancers that are known or suspected to be associated with BMI and physical inactivity were excluded in this study, we only provided the most conservative estimates of AF of cancers to overweight, obesity and physical inactivity in Chinese population. There were certain limitations in our investigation by combining RR estimates from various data sources, and from different countries. It was possible that genetic difference in various populations would have impacts on RR of certain cancers. However, it was difficult to provide accurate estimates on how much such impact would be based on current information.

Systematic assessments of the contribution of overweight/obesity and physical inactivity to cancer burden were available for several countries and regions. AF to overweight/obesity in high-income countries ranged from 3% to 6%, e.g., 5% of cancer cases in the EU [30], 4% of cancer deaths, 6% of cancer cases in Canada [31], 2% to 3% of cancer deaths in French women (together with use of exogenous hormones) [32], and 3.7% of cancer cases in men and 6.2% in women in Japan, after adjusting for smoking [24]. An exception was found in the United States, where the AF to overweight and obesity was estimated to be as high as 14.3% of cancer deaths in women [33]. As with previous studies, our estimates indicated that BMI played a bigger role in cancer death and occurrence in women. Though the overall contribution of BMI (less than 1.0%) in China was low at the current stage, the gap was narrowing between urban Chinese and those in high-income countries.

One of the additional reasons of the lower AF in China as compared to high-income countries was the difference in the distribution of cancers. Colorectal cancer accounted for 7.2% of all incident cases in Chinese women as compared to 12.0% in US women [34]. This was due to its lower incidence and to the higher incidence of other cancers such as liver, stomach and esophageal cancer. In fact, our estimates of the proportion of colon cancer attributable to physical inactivity were comparable to those calculated for other populations, e.g., 7.0% in men, 12.3% in women in France [12], 26% in men, 28% in women in South Africa [35], and 16% globally [36].

Another reason for the lower observed impact on overweight, obesity and physical inactivity might be the differences in life expectancy in China compared to western countries. According to WHO statistics, life expectancies in China in 2000 and 2009 was 71 and 74 yr, which were relatively lower than those in developed countries with life expectancies all above 77 yr (such as the United States, United Kingdom, Germany, Italy , France, and Australia) [37]. There were only a few domestic papers describing the trends on cancer incidence in China. Some studies showed that age specific incidence rate peaks around 75 yr old in colorectal cancer patients [38, 39, 40]. Therefore, it was possible that AFs for overweight and obesity in China were hindered by the lower life expectancy as compared to other western countries. A rapid increase in the prevalence of overweight, obesity and physical inactivity was observed in China during the past decade. It was estimated that the prevalence of Chinese with a BMI ≥25 increased from 14.6% in 1992 to 21.8% in 2002 [5]. And the overall prevalence of occupational physical inactivity increased from 16.5% in 1989 to 24.1% in 2000 [41]. It is likely that this upward trend will continue. Results from our projection (Figures 1 and 2) based on overweight/obesity prevalence in 1992 and 2002 showed that high BMI continued to contribute to the etiology for a large proportion of cancer cases in women and in urban populations. For example, AF for endometrial cancer would increase from 18.91% to 30.44%, and AF of BMI to breast cancer (postmenopausal) would increase from 8.81% to 11.89%, in urban women from 2005 to 2015. The relative increase in AF would be greater in men and rural populations. We found that an approximately 2-fold increase was observed in AFs to cancers of colon, rectum, pancreases and kidney in rural men population from 2005 to 2015. Although the current burden of cancers associated with overweight, obesity, and physical inactivity is still small, it is expected that this burden will increase in the future. Results from our study can be used for future decision-making in cancer prevention and control.

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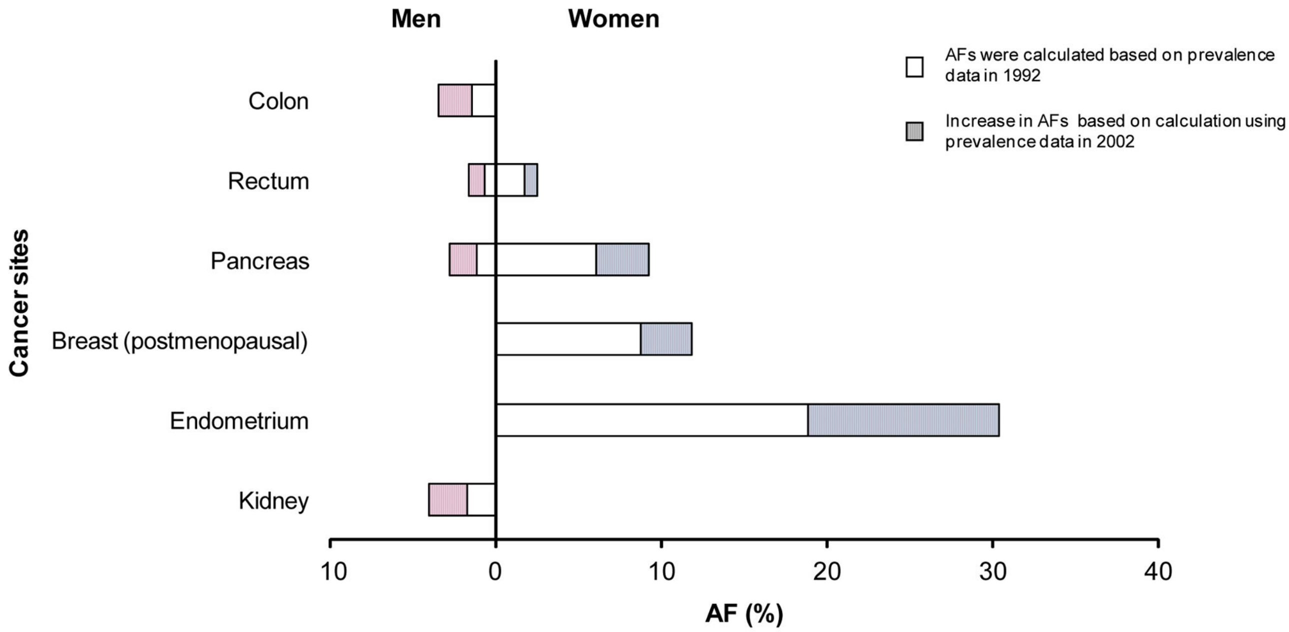

Fig. 1.

Comparison of attributable fractions (AFs) of overweight and obesity of cancers in 2005 and 2015 in urban China

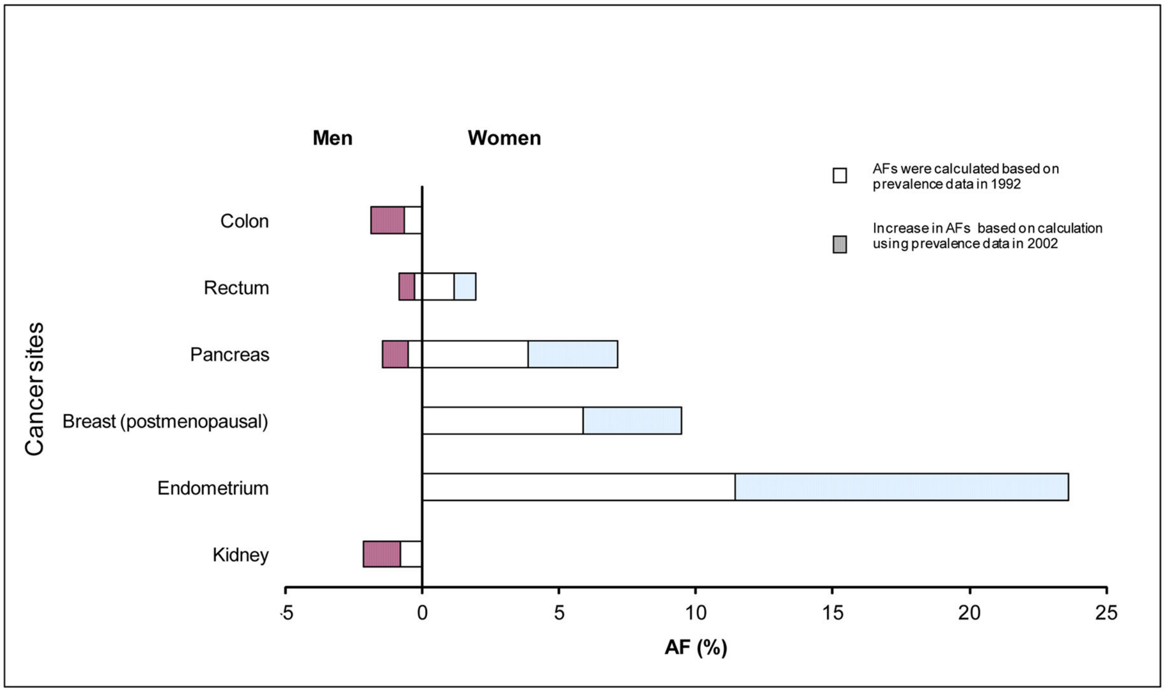

Fig. 2.

Comparison of attributable fractions (AFs) of overweight and obesity of cancers in 2005 and 2015 in rural China

Table 1

Relative risks for overweight and obesity derived from China and East Asia populations*.

Cancer site	Relative risk				References
	Men		Women		
	Overweight	Obesity	Overweight	Obesity	
Colon	1.08	1.42	N/A#	N/A#	KCPS$^{\lambda}$ study [15]
Rectum	1.04	1.16	1.11	1.14	KCPS study [15]
Pancreas	1.06	1.34	1.35	1.80	KCPS study [15]
Breast (post menopausal)	—	—	1.60	1.51	SWHS$^{\eta}$ study, Zheng et al unpublished
Endometrium	—	—	1.94	5.42	SWHS study, Zheng et al unpublished
Kidney	1.06	1.34	N/A#	N/A#	KCPS study [15]

*A body mass index (BMI) equal to or above 25 is regarded as "overweight", whereas a BMI equal to or greater than 30 is graded as "obesity".

#Evaluation of BMI and cancers of colon and kidney in women are excluded due to inconsistent findings from Asian studies, i.e., data were not synthesized due to a low number of cases in study cohorts, or high level of heterogeneity in study designs and BMI cut-offs in Asian studies.

$^{\lambda}$KCPS indicates to "Korean Cancer Prevention Study"[15];

$^{\eta}$SWHS, Shanghai Women's Health Study, unpublished at the time this research was conducted.

Table 2

Prevalence (%) of overweight, obesity and lack of adequate physical activity in China by residence and gender.

Risk factor, year, [reference]	Age group	Men		Women	
		Urban	Rural	Urban	Rural
Overweight, 1992 [16]	20 to 45 yr	12.3	5.3	14.4	9.8
Obesity, 1992 [16]		1.0	0.5	1.7	0.7
Overweight, 2002 [19]	Over 18 yr	24.1	13.6	18.0	14.4
Obesity, 2002 [19]		3.8	1.8	4.3	3.0
Lack of physical activity, 2000 [21]	35 to 74 yr	74.0	19.1	82.7	24.8

Table 3

Number of deaths and new cases for selected cancer sites by residence and gender in China in 2005*.

Residence - Cancer site	ICD-10	Men		Women	
		Deaths	Cases	Deaths	Cases
Urban					
- Colon	C18	12185	26114	N/A#	N/A#
- Rectum	C19-C20	18785	38478	13750	26285
- Pancreas	C25	13732	15229	11191	11915
- Breast (post menopausal)	C50	—	—	16451	53726
- Endometrium	C54	—	—	4628	29255
- Kidney	C64	4376	13358	N/A#	N/A#
Total	C00-96 but C44	526490	753635	312851	572987
Rural					
- Colon	C18	8411	16482	N/A#	N/A#
- Rectum	C19-C20	17353	28931	12278	20190
- Pancreas	C25	7474	8865	5161	5960
- Breast (post menopausal)	C50	—	—	14162	30436
- Endometrium	C54	—	—	5877	16252
- Kidney	C64	2234	3665	N/A#	N/A#
Total	C00-96 but C44	610387	774112	341885	477427
Grand total	C00-96 but C44	1136877	1527747	654736	1050414

*Data on cancer mortality in China in 2005 were derived from The Third National Death Cause Survey, a retrospective survey conducted in 160 randomly selected counties and 53 high-risk areas between 2004 and 2005. A total of 142,660,482 person-yr was covered, including24,300,984 person-yr from urban males, 23,598,822 person-yr from urban females, 48,669,257 person-yr from rural males, and 46,091,419 from rural females.

ICD-10 indicates the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10), a coding of diseases, signs and symptoms, abnormal findings, complaints, social circumstances and external causes of injury or diseases, as classified by the World Health Organization.

#Evaluation of BMI and cancers of colon and kidney in women are excluded due to inconsistent findings from Asian studies, i.e., data were not synthesized due to a low number of cases in cohort studies, or high level of heterogeneity in study designs and BMI cut-offs in Asian studies.

Table 4

Proportion and number of cancer deaths and new cases attributable to overweight and obesity.

Residence - Cancer site	Men			Women		
	AF %[*]	Deaths	Cases	AF %[*]	Deaths	Cases
Urban						
- Colon	1.39	170	364	N/A[#]	N/A[#]	N/A[#]
- Rectum	0.65	122	250	1.80	247	475
- Pancreas	1.07	147	163	6.14	687	732
- Breast (post menopausal)	—	—	—	8.81	1449	4733
- Endometrium	—	—	—	18.91	875	5532
- Kidney	1.71	75	229	N/A[#]	N/A[#]	N/A[#]
Total		514	1006		3259	11472
%		0.10%	0.13%		1.04%	2.00%
Rural						
- Colon	0.63	53	104	N/A[#]	N/A[#]	N/A[#]
- Rectum	0.29	51	84	1.16	143	235
- Pancreas	0.49	36	43	3.87	200	231
- Breast (post menopausal)	—	—	—	5.91	837	1799
- Endometrium	—	—	—	11.44	672	1859
- Kidney	0.77	17	28	N/A[#]	N/A[#]	N/A[#]
Total		157	260		1852	4123
%		0.03%	0.03%		0.54%	0.86%
Grand Total		671	1265		5111	17458
% of all cancers$^{\eta}$		0.06%	0.08%		0.78%	1.48%

[*] AF indicates attributable fraction. For the calculation of AF% please refer to "Statistical Analysis" under Materials and Methods.

[#] Evaluation of BMI and cancers of colon and kidney in women are excluded due to inconsistent findings from Asian studies, i.e., data were not synthesized due to a low number of cases in cohort studies, or high level of heterogeneity in study designs and BMI cut-offs in Asian studies.

$^{\eta}$All cancers but non-melanoma skin.

Table 5

Number of cancer deaths and cases attributable to physical inactivity in China.

	Men			Women		
Residence - Cancer site	**AF%***	**Deaths**	**Cases**	**AF%***	**Deaths**	**Cases**
Urban						
- Colon	23.7%	2888	6189	11.0%	1121	2418
Rural						
- Colon	7.43%	625	1225	3.59%	229	461
Total		3513	7414		1350	2879
% of all cancers#		0.31%	0.49%		0.21%	0.27%

*AF indicates attributable fraction. For the calculation of AF% please refer to "Statistical Analysis" under Materials and Methods.

#All cancers but non-melanoma skin.

Table 6

Summary of Asian studies on the association between BMI and colon and kidney cancer in women.

Cancer Sites	Authors, year, [reference]	Country	Design	Number of cancer cases/deaths included$^{\lambda}$		RR Association (95% confidence intervals) (BMI quantile) $^{\Pi}$	
				Premenopausal	Postmenopausal	Premenopausal	Postmenopausal
Colon	Kuriyama et al., 2005, [24]$^{\eta}$	Japan	Cohort	3	6	1.01 (0.25–4.14) (25.0< BMI <27.4)	2.08 (0.88–4.90) (BMI ≥30)
	Hou et al., 2006, [25]	China	Case-control	62	50	2.9 (1.7–8.6) (BMI >23.6)	0.6 (0.3–0.9) (BMI >23.6)
	Jee et al., 2008, [15]	Korea	Cohort	68		1.01 (0.72–1.42) (BMI ≥ 30)	
	Song et al., 2008, [26]	Korea	Cohort	N/A	32	N/A	2.18 (1.43–3.33) (BMI≥30)
	Zheng et al., unpublished$^{\eta}$	China	Cohort	26		0.79 (0.53–1.19) (BMI >30)	
Kidney	Kuriyama et al., 2005, [24] $^{\eta}$	Japan	Cohort	2		2.60 (0.33–20.61) (25.0< BMI<27.4)	
	Jee et al., 2008, [15]	Korea	Cohort	14		1.21 (0.58–2.53) (BMI≥30)	
	Song et al., 2008, [26]	Korea	Cohort	N/A	29	N/A	2.61 (BMI≥30)
	Zheng et al., unpublished$^{\eta}$	China	Cohort	4		0.95 (0.34–2.67) (BMI >30)	

$^{\eta}$Data on colorectal cancer were included.

$^{\lambda}$Different body mass index (BMI) classifications were used.

$^{\Pi}$Only relative risks (RRs) for the highest BMI quantile and the corresponding cancer cases/deaths were listed.