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Obesity and mortality in a prospective Chinese elderly cohort

Key Messages

1. Research suggesting that obesity is not causally related to mortality in older people could be biased, because body mass index at older ages may represent not only adiposity but also health status and closeness to death. These factors can mask the detrimental effect of adiposity on survival.
2. In healthy, never-smoking, older persons, obesity was associated with higher mortality.
3. In older persons, body mass index should be considered in the context of overall health status, as thinness or sudden weight loss may be an indicator of other health problems.
4. Interventions to prevent obesity at all ages are needed so that obesity does not become an overwhelming public health problem.

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Introduction

Obesity substantially contributes to all-cause and cause-specific mortality in younger and middle-aged adults, which is consistent with known causal pathways in chronic diseases. In older adults (aged ≥65 years) the relation between obesity and mortality is less clear,[1] which raises questions as to whether obesity is causally related to mortality, the significance of obesity in deaths attributable to lifestyle habits,[2] and the appropriate public health interventions for the rapidly growing older population worldwide. Understanding the role of obesity and inactivity in older adults is especially urgent in countries such as China where there are increasing levels of obesity, and an increasing proportion of older people. Hong Kong, that has a long history of economic development and where 95% of the population is ethnically Chinese, can forewarn what may confront older people in mainland China and other developing countries in Asia.

Among older Chinese in Hong Kong, higher body mass index (BMI) has been associated with survival.[3] This finding is similar to that of a recent large, representative study in the United States, showing little excess risk associated with higher BMI in people aged 60 or over.[2] However, these observations could be an artefact of the typical lifetime pattern of weight gain followed by loss and 'reverse causality', where lower BMI is the result, not the cause, of underlying illness and proximity to death.[4] If baseline health status was a 'missing variable' in the observed obesity-mortality relation in older people, the relation between BMI and mortality should differ with health state; high BMI would be a risk factor in healthy people and apparently protective for people in poor health. Identifying whether health status is such a 'missing variable' is crucial to the interpretation of these paradoxical observations of an apparently protective or neutral role of obesity in older people, and hence for assessing the public health impact of obesity. In a large, prospective cohort of older Chinese, we examined the effect of obesity on mortality stratified by baseline health status.

Methods

Study design

This was a prospective, record-linkage study based on data from 18 Elderly Health Centres (EHCs) established in July 1998 by the Department of Health of the Government of the Hong Kong Special Administrative Region. These centres provide health examinations and primary care services for older adults. All subjects who enrolled at the EHCs from July 1998 to December 2000 were included and followed up until 31 December 2003. The unique Hong Kong Identity Card Number was used to link records. Deaths were ascertained from the Hong Kong death registry. Live status was inferred from an attendance at an EHC or a Hospital Authority facility subsequent to 31 December 2003. Enrolees not identified as dead or alive on 31 December 2003 were traced using telephone interviews from November 2004 to January 2005 to ascertain their vital status.

Sample size

All elderly residents in Hong Kong aged 65 or over have been encouraged to enrol at EHCs. More women enrolled than men; otherwise the enrolees were similar in age, socio-economic status, current smoking and hospital use to the general elderly population of Hong Kong. There were 56 167 enrolments at the 18 EHCs from July 1998 to December 2000; of whom 96.5% were successfully followed

Table 1. Adjusted hazard ratios and 95% confidence intervals (CI) for all-cause and cause-specific mortality by body mass index (BMI) of Elderly Health Centre subjects in Hong Kong*

Cause	No. of deaths	Adjusted hazard ratio (95% CI)				
		BMI <18.5	18.5-<23	23-<25	≥25	P value for linear trend
All causes	3819	1.78§ (1.61-1.97)	1	0.84§ (0.77-0.92)	0.75§ (0.70-0.82)	<0.001
All causes excluding deaths within first 2 years	2354	1.72§ (1.51-1.97)	1	0.87† (0.78-0.97)	0.83§ (0.75-0.92)	<0.001
Cause-specific						
Cancer	1503	1.60§ (1.35-1.91)	1	0.81‡ (0.70-0.93)	0.82‡ (0.72-0.92)	<0.001
Cardiovascular	1041	1.13 (0.90-1.42)	1	0.97 (0.83-1.14)	0.81† (0.70-0.94)	0.006
Respiratory	563	3.71§ (3.02-4.54)	1	0.62§ (0.48-0.81)	0.52§ (0.41-0.66)	<0.001
Other and unknown*	712	1.48‡ (1.15-1.89)	1	0.86 (0.70-1.05)	0.70† (0.58-0.84)	<0.001

* Adjusted for age, sex, education, ever-drinking alcohol, ever smoking, monthly personal expenditure, housing, and physical activity
† P<0.05
‡ P<0.005
§ P<0.001

up until 31 December 2003. Of the 54 216 traced subjects, relevant baseline data from 128 of them was missing; the remaining 54 088 elderly therefore formed the cohort for the final analysis.

Study instruments

Obesity was proxied by BMI, defined as weight in kilogram/height in metre.[2] Body mass index was classified according to guidelines for the Asian Pacific population, ie underweight (<18.5), normal (18.5-<23), at risk of obesity or overweight (23-<25), obese categories I (25-<30) and II (≥30). There were few subjects (6.3% in all) in the obese category II, so a single category (≥25) was used.

Causes of death

Causes of death were routinely coded by the governmental Department of Health according to the International Classification of Disease—9th revision before 2001 and 10th revision in and after 2001. Most Hong Kong residents die in hospital and/or have their death certified by a doctor, enabling reasonably accurate ascertainment of cause of death.

Health status

Consistent with other prognostic indices we constructed a simple, but comprehensive, 12-item morbidity index by counting chronic conditions (five items), use of health services (two items), and frailty (three items). We also included an additional two items, specifically relevant to the obesity-mortality relation, ie unintentional weight loss >10 lb in the last 6 months and ever-smoking.[2] Thus healthy never-smokers and ever-smokers were automatically separated into different health states. Chronic diseases included were: heart disease, stroke, diabetes, chronic obstructive pulmonary disease/asthma, and hypertension (reported or measured blood pressure ≥140/90 mm Hg). Measures of health service use were regular use of medications and any hospital admission in the last year. Measures of frailty were cognitive impairment (Abbreviated Mental Test-Modified score <8), functional impairment (Activities of Daily Living (Katz index)/Instrumental Activities of Daily Living scales score >12), and two or more falls in the last 6 months. Current cancer status was not ascertained, because people receiving cancer treatment were not enrolled in the primary care service. Health status was categorised into five groups based on this 12-item morbidity index, as a count of 0, 1, 2, 3, and 4 or more of the 12 items.

Statistical analysis

The Cox proportional hazards model was used to estimate the hazard ratios (HRs) and the 95% confidence intervals (CIs) for all-cause and cause-specific mortality by BMI group adjusted for baseline confounders (age in 5-year age-groups, sex, education, monthly personal expenditure, housing type, ever use of alcohol, physical activity, and ever-smoking [if appropriate]). Men and women were analysed together, because the BMI-mortality relation was found to be similar in men and women. Whether the BMI-mortality relation was the same in all health statuses was assessed from the significance of interaction terms. The proportional hazards assumption of Cox regression was checked by visual inspection of plots of log (- log [S]) against time, where S was the estimated survival function. For cause-specific analyses, subjects who died of any other causes were regarded as censored at the date of death. Ethics approval was obtained from the Ethics Committee of the Faculty of Medicine, the University of Hong Kong.

Results

At baseline, high BMI was more common in younger age-groups, women, the less educated, and never-smokers. Poor health status was associated with overweight and underweight. Good health status was associated with normal weight.

After a mean follow-up of 4.1 (standard deviation, 0.9) years, 3819 had died. Adjusting for age, sex, socio-economic status and lifestyle habits, higher BMI was associated with lower mortality (Table 1) in a dose-response manner. The lowest risk of mortality was in the highest BMI group (HR, 0.75; 95% CI, 0.70-0.82), compared with the normal BMI group. The association between higher BMI and survival was strongest for respiratory mortality and weakest

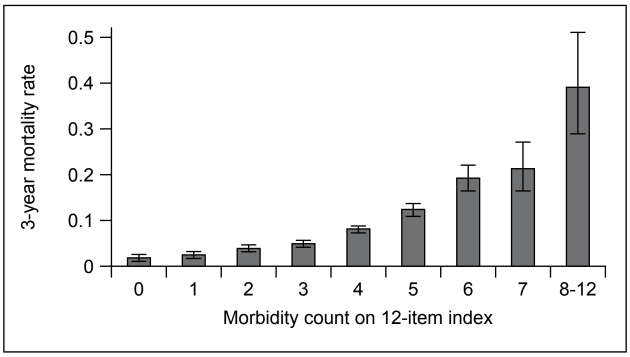

Fig. The Kaplan-Meier estimate of the 3-year mortality rate with associated 95% confidence intervals (error bars) by number of items on the 12-item morbidity index

for cardiovascular mortality. The proportional hazards assumption of the Cox regression model was satisfied for BMI in these models.

The crude 3-year mortality rate increased steadily with the 12-item morbidity status index (Fig), indicating that poor health was associated with mortality. There was a significant interaction (P<0.001) between baseline health status and BMI, indicating that the BMI-mortality relation varied with baseline health status. Higher BMI was most strongly associated with survival for those in the worst health (Table 2), had less effect in intermediate health status and finally reversed in the 'healthy' group, where high BMI was significantly associated with mortality (HR, 1.54; 95% CI, 1.02-2.33), compared with normal BMI. Underweight was consistently associated with higher mortality.

Discussion

In a large, prospective study with detailed and wide-ranging baseline information on health status, a short follow-up period and a high response rate, higher BMI was apparently related to survival. However, the BMI-mortality relation was not consistent, varying with cause of death and most importantly with baseline health status. In older Chinese in poor health with a high mortality rate, there was an inverse, dose-response relation between BMI and mortality, strongest in those with the worst health. In contrast, in healthy, never-smoking older Chinese there was a positive relation between obesity and mortality as in younger adults.

There is no known physiological mechanism for a causally protective role of adiposity, which is only evident in ill-health and which is strongest in the sickest and those with respiratory diseases. On the contrary, confounding by health status and hence proximity to death provides an explanation for our findings. Firstly, BMI may be a marker of factors, such as fitness or maintenance of muscle mass, which predominate over the detrimental effects of adiposity at the end of life, but do not negate the role of adiposity on morbidity and mortality across the lifespan. For an older person, with multiple health problems, high BMI may indicate the disease process is not yet overwhelming and extending to cachexia whilst lower BMI may indicate overwhelming disease. In this case, higher BMI represents less severe disease, and so may appear protective, but as a marker of health status, not causality. Secondly, there are the opposing effects of adiposity contributing to both morbidity and mortality but also of poor health contributing to weight loss before death, as part of the dying process.[5] The normal BMI group consists of a mix of the 'lifetime lean' and the 'formerly fat', ie people who have lost weight on the trajectory towards death, whilst the high BMI groups consist of the surviving overweight, ie those for whom death is less close. Thus, BMI measured at older ages will understate the detrimental effect of adiposity, particularly for those in poor health.

Conclusions

The effect of obesity on mortality varied with health status in older people. There are no known physiological reasons for this variation. Our study adds weight to the hitherto unsubstantiated argument that observed relation between obesity and mortality in older persons are artefactual results of 'reverse causality', probably induced by baseline morbidity whose end-point is death being preceded by weight loss. Observations of higher BMI being associated with survival should not be interpreted as causal, without considering the often unmeasured effect of health status.

Table 2. Adjusted hazard ratios and 95% confidence intervals (CI) for all-cause mortality by body mass index (BMI) of Elderly Health Centre subjects in Hong Kong stratified by baseline health status*

Health status at baseline†	No. of deaths	Adjusted hazard ratio (95% CI)				
		BMI <18.5	18.5-<23	23-<25	≥25	P for linear trend
4-12 ('worst health')	1481	1.76§ (1.51-2.07)	1.00	0.72§ (0.63-0.83)	0.55§ (0.49-0.63)	<0.001
3	894	1.81§ (1.45-2.26)	1.00	0.70§ (0.58-0.84)	0.64§ (0.55-0.75)	<0.001
2	864	2.22§ (1.81-2.73)	1.00	0.82‡ (0.68-0.99)	0.72§ (0.61-0.85)	<0.001
1	446	1.41‡ (1.01-1.97)	1.00	1.04 (0.81-1.33)	0.98 (0.78-1.23)	0.68
None ('best health')	134	1.76‡ (1.00-3.08)	1.00	0.96 (0.58-1.59)	1.54† (1.02-2.33)	0.16

* Adjusted for age, sex, education, ever-drinking alcohol, ever smoking, monthly personal expenditure, housing, and physical activity
† Count of morbidities on the 12-item index
‡ P<0.05
§ P<0.001

To our knowledge, our study is the first to demonstrate that over a short follow-up period (<5 years), high BMI was associated with higher mortality for never-smoking older adults in good health. Recent research suggesting there are few excess deaths due to obesity[2] should not distract us from the urgent need for public health interventions to combat obesity at all ages, possibly with the greatest benefit accruing from preventing obesity in the young and middle-aged, rather than older people. Proper interpretation of the effects of adiposity in old age is urgent and key to developing effective public health strategies.

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