PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (**http://bmjopen.bmj.com/site/about/resources/checklist.pdf**) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

ARTICLE DETAILS

TITLE (PROVISIONAL)	Economic Burden of Excess Weight Among Older Adults in Singapore: A Cross-Sectional Study
AUTHORS	Junxing, Chay; Vinh Anh, Huynh; Lamoureux, Ecosse; Tham, Kwang Wei; Finkelstein, Eric

VERSION 1 – REVIEW

REVIEWER	Silva Canella, Daniela Universidade do Rio de Janeiro, Department of Applied Nutrition
REVIEW RETURNED	14-Jun-2022

GENERAL COMMENTS	It is an interesting and relevant article to the public health field that estimate the incremental per capita and aggregate costs of excess weight among older adults in Singapore. The article is well written and organized and seems to be well conducted. Most of my commentaries are related to the Methods section searching mainly to clarify it. Abstract The abstract is a little confusing. I understand the limited number of words, but I believe that some changes can turn it clearer and more interesting for the readers. Line 7. In the objective, I suggest mentioning that direct and indirect costs were estimated. Line 11. What are Cross-sectional regressions? It would be better only mentioning the cross-section design and if it would be necessary to mention regressions, do this in the last part of Methods. Line 25. Where is written “attributable cost” should be “incremental cost”, shouldn’t it? Introduction Lines 38-43. It is important to include reference(s) for this information. Considering the perspective of the cost of illness, it would be interesting to include some information about the health system in Singapore. Is it public, private or there are both? Methods Study Population. Lines 25-30. The topic is about Population and this information is about Data collection. I suggest expanding the title of the topic or separating this extract in a new topic. What is being considered medical history? Is it a diagnosis at some moment in life? Or at a specific moment? Is it considering the use of medication for the diseases? Since there is the possibility of a person refers not having hypertension because it is under control due to the use of drugs.

	Additionally, why only these three conditions were considered (diabetes, hypertension and high cholesterol)? It would be important to mention this. Healthcare expenditure. Is it referring to public and/or private services? Line 3. The period of one month for outpatient visits, including hospital outpatient clinic or physician's office visits is short, even for chronic conditions. It should be included as a limitation. Line 11. What means non-subsidized unit costs? Is it related to out-of-pocket expenditure? It would be important to clarify this since the reality of Singapore can be unknown to the audience of BMJ Open. Statistical analysis. About the regressions, why these variables were included in the adjusted model? How they were selected? Additionally, it would be possible to include one analysis for all ethnic groups together, using weighted regression. Results Attributable Cost of Excess Weight. Line 16. The cost of $720 is the incremental cost, not the attributable one, isn't it? Discussion The authors made a good discussion of their data, but I would like to also see a discussion with other realities (countries or ethnic groups, for example).

REVIEWER	Hoque, Mohammad The University of Sydney
REVIEW RETURNED	10-Aug-2022

GENERAL COMMENTS	1. It would be better if the authors mention if the health care utilization was in general for any reason, or related to specific disease mentioned in line 27/28. 2. Line 35/36, why 20 workdays in a month? A month is more than 4 weeks (4.2 weeks). It would be good if provide any justification such as considering other holidays etc. 3. A male -female comparison will be more interesting, in addition to ethnic groups.

VERSION 1 – AUTHOR RESPONSE

Response to Reviewers

Reviewer: 1

Dr. Daniela Silva Canella, Universidade do Rio de Janeiro Comments to the Author:
It is an interesting and relevant article to the public health field that estimate the incremental per capita and aggregate costs of excess weight among older adults in Singapore. The article is well written and organized and seems to be well conducted. Most of my commentaries are related to the Methods section searching mainly to clarify it.

1. Abstract
   The abstract is a little confusing. I understand the limited number of words, but I believe that some changes can turn it clearer and more interesting for the readers.
   Line 7. In the objective, I suggest mentioning that direct and indirect costs were estimated.

Response: We have modified the Objectives statement in our abstract to read as follows:

"…this study aims to estimate the incremental per capita and aggregate direct and indirect costs of excess weight among older adults (aged 40 to 80) in Singapore."

2. Line 11. What are Cross-sectional regressions? It would be better only mentioning the cross-section design and if it would be necessary to mention regressions, do this in the last part of Methods.

Response: We have modified the Methods statement in our abstract to read as follows:
"**Design**: Secondary data analysis of a cross-sectional survey
Setting: Residential districts in South-West Singapore
Participants: 5,848 older adults (aged 40 to 80) from Singapore's three dominant ethnic groups
Primary and secondary outcome measures: We used regression models to estimate per capita medical expenditure and absenteeism costs attributable to overweight and obesity based on World Health Organization's body-mass index (BMI) classification…"

3. Line 25. Where is written "attributable cost" should be "incremental cost", shouldn't it?

Response: We have changed the Results in our abstract to read as follows: "In the obese category, the incremental cost was S$720 per year for medical expenditure…"

4. Introduction
Lines 38-43. It is important to include reference(s) for this information.

Response: We thank the reviewer for raising this point. We have added the following references:
1. Tan CC, Lam CSP, Matchar DB, Zee YK, Wong JEL. Singapore's health-care system: key features, challenges, and shifts. *The Lancet*. 2021;398(10305):1091-1104. doi:10.1016/S0140-6736(21)00252-X
2. Singapore Ministry of Health. *National Population Health Survey 2020*. 2021. https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2020-survey-report.pdf

5. Considering the perspective of the cost of illness, it would be interesting to include some information about the health system in Singapore. Is it public, private or there are both?

Response: We thank the reviewer for raising this point. We have added the following description in the manuscript in the introduction 3rd paragraph:
"Singapore has an island network of outpatient polyclinics and private medical practitioner's clinics to provide primary medical treatments, preventive healthcare as well as health education. Eighty percent of primary healthcare services are offered by over 1,800 private medical clinics; whereas the remaining are delivered by 23 government polyclinics. [7] By contrast to primary healthcare, public hospitals provide 80% of hospital care. [8] Payment for services is a combination of out-of-pocket spending, health savings accounts (called MediSave), high deductible health plans (termed MediShield Life), and subsidies for low-income patients (termed MediFund)."

[7] Singapore MoH. Primary Healthcare Services. https://www.moh.gov.sg/home/our-healthcare-system/healthcare-services-and-facilities/primary-healthcare-services
[8] Khoo L. *Singapore Healthcare Market-Share Analysis*. 2003. *MOH Information Paper*. https://www.moh.gov.sg/docs/librariesprovider5/resources-statistics/information-papers/singapore_healthcare_market-share_analysis.pdf

6. Methods
Study Population. Lines 25-30. The topic is about Population and this information is about Data collection. I suggest expanding the title of the topic or separating this extract in a new topic.

Response: We have expanded the title in the manuscript as follows:
"Study Population and data collection"

7. What is being considered medical history? Is it a diagnosis at some moment in life? Or at a specific moment? Is it considering the use of medication for the diseases? Since there is the possibility of a person refers not having hypertension because it is under control due to the use of drugs.

Response: We thank the reviewer for raising this point. The participants were asked if they have ever been diagnosed with the conditions in the past. As such, it is unlikely that participants would report not having the condition even if the condition is under control. We have also clarified this in the manuscript:
"…self-reported medical history (ever been diagnosed with diabetes, hypertension, high cholesterol) were collected…"

8. Additionally, why only these three conditions were considered (diabetes, hypertension and high cholesterol)? It would be important to mention this.

Response: These conditions were comorbidities of eye diseases and of interest to the original aim of the Singapore Epidemiology of Eye Diseases (SEED) cohort study [1], which is to evaluate the incidence, prevalence, risk factors and novel biomarkers of age-related eye diseases
We now state 'These are the only conditions captured in the data where obesity is a primary risk factor.'

[1] Majithia S, Tham YC, Chee ML, et al. Cohort Profile: The Singapore Epidemiology of Eye Diseases study (SEED). *Int J Epidemiol*. Mar 3 2021;50(1):41-52. doi:10.1093/ije/dyaa238

9. Healthcare expenditure. Is it referring to public and/or private services?

Response: We have added the following to "Healthcare expenditure" sub-section to clarify:
"We examined healthcare expenditure from a whole system perspective which includes both public and private services. Costs of providing these services were proxied by non-subsidized bill sizes from the public sector [1], which are set to reflect true costs."
Footnote [1]: Publicly funded hospitals in Singapore provide substantial subsidies based on means-testing of patients' household income level.

10. Line 3. The period of one month for outpatient visits, including hospital outpatient clinic or physician's office visits is short, even for chronic conditions. It should be included as a limitation.

Response: Thank you for raising this point. We have added the following to our limitations section:
"…In particular, the recall period of one month for outpatient visits, including hospital outpatient clinic or physician's office visits is short. However, it is unclear whether a longer recall period would be preferable as this may result in an underestimate of utilization, especially for high utilizers who may not be able to recall all visits over an extended period."

11. Line 11. What means non-subsidized unit costs? Is it related to out-of-pocket expenditure? It would be important to clarify this since the reality of Singapore can be unknown to the audience of BMJ Open.

Response: Non-subsidized costs are meant to proxy for the true cost of providing a healthcare service. Healthcare services in Singapore are means-tested and can be subsidized heavily by the government for those with lower income. The following has been added earlier in the "Health Expenditure" sub-section to clarify:
"We examined healthcare expenditure from a whole system perspective which includes both public and private services. Costs of providing these services were proxied by non-subsidized bill sizes from the public sector, which are set to reflect true costs [1]."
Footnote [1]: Publicly funded hospitals in Singapore provide substantial subsidies based on means-testing of patients' household income level.

12. Statistical analysis.
About the regressions, why these variables were included in the adjusted model? How they were selected?

Response: These variables were included to reduce the influence of omitted variable bias, and to improve statistical precision of our estimates. These variables are common controls used in burden of illness studies and are selected on the basis of being correlated both healthcare utilization and BMI.

13. Additionally, it would be possible to include one analysis for all ethnic groups together, using weighted regression.

Response:
We have analysed a weighted regression with all ethnic groups included. However, the results for medical expenditure, absenteeism days and cost follow very closely those of Chinese-only model (as expected since Chinese make up of close to 80% of the Singapore population). As such, while we acknowledge that the results for an "average Singaporean" are potentially interesting, we believe the ethnicity-specific result estimates are more interesting and important to our research hypothesis and conclusion. We have reproduced Table 3 with the inclusion of the all-ethnic-groups model below.

Table 3. Incremental Per Capita Medical Expenditures and Productivity Losses Due to Excess Weight (regression-controlled).

	Medical expenditure, S$ (95% CI)	Absenteeism days (95% CI)^	Absenteeism cost, S$ (95% CI) ^
Chinese			
Normal (ref)	-	-	-
Overweight	57 (-143, 256)	1.0** (0.0, 1.9)	176* (-16, 368)
Obese	720** (96, 1345)	1.6 (-1.1, 4.2)	261 (-242, 764)
Number of observations	2,427	1,335	1,335
Indian			
Normal (ref)	-	-	-
Overweight	13 (-254, 280)	0.4 (-1.0, 1.8)	54 (-123, 231)
Obese	18 (-328, 364)	2.1 (-0.5, 4.6)	396* (-17, 809)
Number of observations	2,107	1,166	1,166
Malay			
Normal (ref)	-	-	-
Overweight	104 (-372, 580)	0.8 (-1.3, 2.8)	96 (-312, 504)
Obese	325 (-198, 848)	0.7 (-1.6, 3.0)	244 (-254, 742)
Number of observations	1,225	515	515
Overall#			
Normal (ref)	-	-	-
Overweight	67 (-149, 282)	1.0** (0.1, 2.0)	167* (-5, 339)
Obese	617*** (176, 1058)	1.9 (-0.5, 4.2)	332* (-20, 683)
Number of observations	5,759	3,016	3,016

CI, confidence interval; Reference category is Normal, 18.5 – 24.9 kg/m^2; Overweight, 25.0 – 29.9 kg/m^2; Obese, 30.0+ kg/m^2;

Weighted by population proportions;

^ Among employed workers only

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

14. Results.
    Attributable Cost of Excess Weight. Line 16. The cost of $720 is the incremental cost, not the attributable one, isn't it?

Response: We have changed the wording to read as follows:
"For Chinese in the obese category, the incremental medical cost was S$720 per year …"

15. Discussion.
    The authors made a good discussion of their data, but I would like to also see a discussion with other realities (countries or ethnic groups, for example).

Response: We thank the reviewer for the positive feedback. We have added to the "Discussion" section as follows:
"A study in Malaysia, Singapore's neighbour with similarly diverse ethnicities, highlighted similar differences between obesity prevalence among ethnic groups, with obesity prevalence highest among Malays and Indians, follows by Chinese.[17] Differences in medical spending across races were also found in the US, where excess weight had significant impact on healthcare expenditure among whites but not blacks or Hispanics.[18] These studies and ours highlight the uneven distribution of obesity burden across different ethnic groups."

[17] Rampal L, Rampal S, Khor GL, et al. A national study on the prevalence of obesity among 16,127 Malaysians. *Asia Pac J Clin Nutr*. 2007;16(3):561-6.
[18] Wee CC, Phillips RS, Legedza AT, et al. Health care expenditures associated with overweight and obesity among US adults: importance of age and race. *Am J Public Health*. Jan 2005;95(1):159-65. doi:10.2105/ajph.2003.027946

Reviewer: 2
Dr. Mohammad Hoque, The University of Sydney Comments to the Author:

1. It would be better if the authors mention if the health care utilization was in general for any reason, or related to specific disease mentioned in line 27/28.

Response: We thank the reviewer for raising this point. We added details to the text as follows:
"… included a healthcare utilization (inpatient admission, outpatient visits and emergency department admission for any reason) and productivity loss component was added to the study."

2. Line 35/36, why 20 workdays in a month? A month is more than 4 weeks (4.2 weeks). It would be good if provide any justification such as considering other holidays etc.

Response: We have added the following to clarify:
"…assuming 20 workdays in a month (excluding approximately twelve public holidays in Singapore and assuming two weeks of vacation)"

3. A male -female comparison will be more interesting, in addition to ethnic groups.

Response:In response to this comment, we further analysed the effect of gender by including an interaction term between BMI category and female within each single-ethnicity model. However, we did not find any statistically significant effect of gender on healthcare expenditure or absenteeism days. This may be partly due to the small sample size when stratifying results by ethnicity, BMI category, and gender. Results are shown below. No changes were made to the manuscript, but we will do so at the editors' request.

Table X. Incremental burden by BMI category and gender.

	Medical expenditure		Absenteeism days		Absenteeism cost	
	S$ (95% CI)	p-value†	(95% CI)^	p-value†	S$ (95% CI) ^	p-value†
Chinese						
Normal (ref)	-	0.476	-	0.399	-	0.834
Overweight						
Male	88 (-195, 371)		0.5 (-0.6, 1.6)		106 (-112, 324)	
Female	16 (-286, 318)		2.0** (0.1, 3.9)		218 (-83, 518)	
Obese						
Male	1171** (133, 2210)		1.9 (-1.7, 5.5)		332 (-385, 1050)	
Female	370 (-424, 1165)		1.3 (-3, 5.6)		329 (-835, 1494)	
Number of observations	2,427		1,335		1,335	
Indian						
Normal (ref)	-	0.438	-	0.578	-	0.461
Overweight						
Male	-73 (-505, 359)		-0.3 (-2.3, 1.7)		-52 (-261, 156)	
Female	94 (-253, 440)		0.7 (-1.4, 2.9)		138 (-85, 362)	
Obese						
Male	-279 (-885, 327)		0.5 (-2.5, 3.5)		238 (-279, 755)	
Female	195 (-215, 604)		2.8 (-0.6, 6.1)		403* (-34, 839)	
Number of observations	2,107		1,166		1,166	
Malay						
Normal (ref)	-	0.937	-	0.285	-	0.039
Overweight						
Male	92 (-599, 784)		1.9 (-1.2, 5)		362 (-149, 872)	
Female	84 (-592, 759)		-0.8 (-2.9, 1.3)		-198 (-570, 174)	
Obese						
Male	233 (-558, 1025)		0.1 (-2.7, 3)		-97 (-453, 260)	
Female	410 (-354, 1175)		0.8 (-2.2, 3.8)		189 (-333, 710)	
Number of observations	1,225		515		515	

CI, confidence interval; Reference category is Normal, 18.5 – 24.9 kg/m^2; Overweight, 25.0 – 29.9 kg/m^2; Obese, ≥30.0 kg/m^2; ^ Among employed workers only; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; †: p-value of the Wald test that jointly tests whether the incremental burden of each weight category differs by gender.

VERSION 2 – REVIEW

REVIEWER	Hoque, Mohammad The University of Sydney
REVIEW RETURNED	22-Aug-2022

GENERAL COMMENTS	Well done.

VERSION 2 – AUTHOR RESPONSE

Reviewer: 2

Dr. Mohammad Hoque, The University of Sydney

Comments to the Author:

Well done.

Response: We thank the reviewer for the positive comment.