

**Investigating the relationship between smoking and individual health expenditures: a
case study of Namibia**

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Dissertation submitted in partial
fulfillment of the requirement for the degree
Master of Public Health (MPH) in Health Economics

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February 2017

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Abstract

Background

The increased smoking prevalence in some parts of the world, particularly in Low and Middle Income Countries (LMICs) is a major concern among tobacco control advocates and governments. The higher smoking-related disease prevalence associated with this is expected to fall among the sub-populations least able to pay for healthcare services in LMICs. This, in turn, will perpetuate the vicious cycle of poverty and disease. The current study contributes to developing an understanding of the socioeconomic disparities in smoking in Namibia and their potential association with per capita health-related expenditures.

Method

Data from the Namibia 2013 Demographic and Health Survey, a nationally representative survey, are used in the study. Three main variables for healthcare costs are constructed, namely out-patient disease (OPD) costs, inpatient disease (IPD) costs and total out of pocket (OOP) payments. Concentration curves and indices are estimated for all three variables as well as for smoking intensity and smoking prevalence. Further, three Tobit regression models are run to examine the associations of the different healthcare costs with smoking intensity.

Results

The concentration index of smoking prevalence is estimated at -0.05 compared to -0.18 for smoking intensity. Thus, both smoking prevalence and smoking intensity, in relation to their socioeconomic status, are concentrated among the poor. In contrast, the concentration index of OPD healthcare costs is calculated at 0.34 compared to 0.65 for IPD healthcare costs reflecting disproportionately higher healthcare costs among the rich. The concentration index of the overall total annual OOP payments is 0.55. Tobit regression analysis, however, does not find any statistically significant relationship between the smoking intensity and the

amount spent on health care costs, regardless of whether these were IPD, OPD healthcare costs or total OOP payments.

Conclusion

Namibia's current policies on demand reducing tobacco control policies can be strengthened by these findings. Smoking is an important determinant of several non-communicable diseases and has the potential to exacerbate health care costs across socioeconomic strata. Understanding the socioeconomic disparities in smoking is imperative for developing appropriate interventions against smoking.

Dedication

To my wife for her unwavering support and for entertaining the 'crazy' idea to marry me and to let me go to school a month later. Thank you for believing in me!

To my parents for their support through the years.

To the unseen God whose favour and grace over my life continue to show up in unexpected ways.

Acknowledgements

I would like to thank Prof. Corne van Walbeek for funding my studies through the Economics of Tobacco Control Project with funding from the Africa Capacity Building Foundation and the Bill & Melinda Gates Foundation.

I would like to thank the Health Economics Unit for the academic instruction and support, and inspiring my research interests in the field of public health.

Lastly, I would like to thank my supervisor, Dr John Ataguba, for encouraging my ideas, steering me on the right path and providing valuable guidance and supervision throughout this journey.

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A. Research Protocol

1. Introduction

1.1 Background

The economic cost of cigarette smoking has been an area of interest in the fields of economics and public health for some time now (1). Globally, over the next 20 years an estimated economic loss of about US\$12.7 trillion or the equivalent of 1.3 percent of GDP annually could be attributed to tobacco use (2). This significant economic loss will largely be borne by low and middle income countries, exacerbating the already dire scenario with high mortality rates and strained health systems.

It is estimated that smoking prevalence in the African region is expected to increase from 15.8 percent in 2010 to 21.9 percent by 2030 – the largest expected increase by region (3). This rapid increase is largely due to the tobacco industry's efforts to expand its market share in these parts of the world. Tobacco use, traditionally a male dominated activity, is expected to increase particularly among women and young smokers, as well as in terms of variety in forms use (African Union, 2013; Guindon, Guindon, Boisclair, & Boisclair, 2003; Hosseinpoor, Parker, Tursan d'Espaignet, & Chatterji, 2011). The expected morbidity and mortality increases resulting from this could have devastating effects on the development and economic growth of these countries. The resulting impact on poor households is also expected to be severe, increasing the risks of catastrophic household expenditure on health and pushing them deeper into poverty.

Using data from Namibia's 2000 Demographic Health Survey (DHS), Pampel estimated the country's smoking prevalence at 17.5 percent while the 2013 DHS reported smoking prevalence of 19 percent and 5 percent for men and women, respectively (7,8). However more recently, the WHO estimated the smoking prevalence to be even higher at around 20

percent with rising smoking-associated risk and incidence of non-communicable diseases in the country (9).

In addition, out-of-pocket (OOP) payments for health care as a percent of total health expenditure have risen over the last few years from 6 percent in 2010 to 11 percent in 2013 (10). This is still below 20 percent of total health expenditure and as such it is anticipated that catastrophic health expenditures and impoverishment will be low the country (11). However, because households face the full burden of OOP payments, it is an inequitable means of health care financing and is often inefficient. This, coupled with the fact that poor households face the most deleterious effects of health shocks resulting in catastrophic payments, make monitoring the impact of tobacco use on OOP payments especially important.

1.2 Study rationale

Tobacco smoking greatly increases the risk of several serious medical conditions including cardiovascular disease, cancer, respiratory diseases and peripheral vascular disease (12). In addition, exposure to second hand smoke is also a cause of morbidity and mortality in adults and children that do not smoke (13). This burden of disease typically falls disproportionately on those in lower socioeconomic brackets further exacerbating poor health conditions, lowering life expectancy and perpetuating the health poverty trap. The health poverty trap is a self-reinforcing cycle in which poor health leads to higher poverty and vice versa, making it difficult for the poor to break from the cycle (14).

Like many countries in sub-Saharan Africa, Namibia is grappling with the issue of social inequalities. The colonial apartheid legacies of the country had an indelible mark on its level of income inequality and in the mid-90s it had a Gini coefficient of 0.70, representing one of the highest levels of income inequality in the world (15). It still remains one of the most

unequal countries in the world with a more recent estimate of the Gini coefficient at 0.61 according to the United Nation Human Development Report of 2015 (16). Briefly, the Gini coefficient ranges between 0 and 1 and can be used to measure the concentration of a distribution. High concentrations represent high inequality and low concentrations represent low inequality.

This study will contribute to developing a better understanding of the socioeconomic inequalities in smoking in Namibia and how this potentially impacts individual health-related expenditures. The importance of this study in assisting the formulation of policies alive to the impending tobacco epidemic and its implications on reducing poverty and income inequality in the country cannot be overstated.

1.3 Literature review

Early studies on the economic cost of smoking focussed on known diseases caused by smoking to estimate smoking-attributable costs at a point in time. Thompson for instance, proposed estimating per capita healthcare cost by age group in Canada and found that 15 percent of male and percent of female healthcare costs could be attributed to smoking (17). Around the same period, Leu and Schaub used econometric models to estimate the lifetime medical expenditures for Swiss males from the age of 35 years and found that these expenditures would be higher for non-smokers than for smokers (18,19).

However, the most commonly used approach for estimating the economic cost of smoking is the cost of illness approach developed by Rice and colleagues (20,21). This approach adopts a prevalence-based analysis that divides costs into direct and indirect costs, and analyses the impact of illness from a macroeconomic perspective. Hodgson using this approach, found that for the population in the United States, total expected lifetime expenditures from the age of 17 years was higher for smokers than non-smokers, contrary to Leu and Schaub's earlier

study (22). Importantly, the Hodgson study concluded that lifetime expenditures were 21 percent and 47 percent higher for moderate and heavy smokers respectively, compared to never-smokers, thus making the link between intensity of smoking and higher impact on medical expenditures.

Since then several studies have estimated both static and lifetime costs attributable to smoking across various settings. The majority of these studies have found that smokers had higher medical expenditures or higher expected lifetime medical expenditures than non-smokers (23–28). Only one study conducted in the USA looking at the cost of cessation of smoking found that while savings would be attained in the short run, increased healthcare expenditures were expected over a lifetime (29). Despite this somewhat contrary finding, there remains general consensus that quitting smoking remains socially desirable.

Socioeconomic inequalities also exist in the distribution of smoking in many countries (30,31). The literature shows that various dimensions of socioeconomic status (SES) have been examined in relation to smoking. For instance education, occupational status and income were all found to be inversely related to smoking (32). There are similarities in the general patterns of smoking prevalence and intensity across SES. Hiscock et al. concluded that increased smoking prevalence will likely result in increased inequalities especially in terms of incidence of smoking related diseases (30).

Notably, the majority of the cost of smoking studies have all been in developed countries, with only a few focussed on developing countries, mainly in Asia (21,27,33–36). The socioeconomic aspects have also been scarcely explored in developing country settings. This is partly due to the stage in which most developing, and especially African, countries find themselves in along the tobacco epidemic four-stage model¹. This has left a dearth of

¹ The tobacco epidemic four-stage epidemiological model was developed in the mid 90's by Lopez et al., and showed the trends in tobacco use and effect over a 100-year observation in high income countries (100). Briefly,

evidence on the impact of smoking on medical expenditures and a general ambiguity in the distribution of smoking across various socioeconomic strata in Africa.

The economics of tobacco control could potentially benefit from more studies on this, particularly with respect to the impact on household and individual expenditures in healthcare. This is especially important for countries reputed for high OOP healthcare payments. The current study will contribute to this body of knowledge by investigating the impact of smoking on healthcare expenditure in Namibia using econometric methods.

1.4 Objective

The primary objectives of this study will be to assess:

- The socio-economic inequality in smoking intensity in the country.
- The impact of smoking intensity on health expenditure at individual level.

2. Methods

2.1 Source of data

The 2013 Namibia Demographic Health Survey (DHS) data will be used for the study. The DHS is a nationally representative survey conducted in various countries across the world. This 2013 DHS was the fourth comprehensive population and health survey conducted in the country as part of the global DHS programme. It was implemented by the Ministry of Health and Social Services (MoHSS) in collaboration with the Namibia Statistics Agency (NSA) and the National Institute of Pathology (NIP) with technical support provided by ICF

stage one is the beginning of the epidemic where male smoking prevalence is below 15 percent and female prevalence even lower, between 5-10 percent. It lasts about 20 years during which tobacco use becomes more socially acceptable and smoking-attributable mortality is low. Stage two, is characterised by a rapid increase in male smoking prevalence to peak between 50-80 percent, with female smoking prevalence also on the increase but still lagging. This period, lasting about 20-30 years experiences substantial increase in smoking-attributable morbidity and mortality. Stage 3 experiences drastic increases in mortality due to smoking, especially among men and socioeconomic disparities in the impact of smoking become apparent. Stage 4 is the decline stage of the epidemic in which both male and female smoking prevalence is rescinding. However, female smoking-attributable mortality may continue increasing before peaking towards the end of the stage. The model was developed using observations from high income countries, but still remains relevant for developing country settings, most of which are believed to be in the first stage of such an epidemic (101).

International, as well as financial support from the Government of Namibia, the United States Agency for International Development (USAID), and the Global Fund.

The study began in April 2012 and data collection implemented over a five month period between May and September 2013 (8). The study used a preliminary sampling frame from the 2011 Namibia Population and Housing Census which contained a full list of all enumeration areas (EAs) in the whole country. An EA is a geographical area that covers an adequate number of households and serves as a counting unit for the population census.

The 2013 Namibia DHS used a two-stage stratified cluster sample with sampling probabilities calculated separately for each sampling stage and for each cluster. In stage one, 554 EAs were selected with a stratified probability proportional to size selection from the sampling frame. The country's 13 regions were stratified into 26 sampling strata – 13 rural and 13 urban strata. A predetermined number of EAs were independently selected in every stratum from a complete list of households. Stage two involved the selection of 20 households in every urban and rural cluster according to equal probability systematic sampling.

The survey provided demographic, socioeconomic, and health data at both national and regional levels for policymaking and planning purposes. Three questionnaires were administered in the survey – the household questionnaire, the women's questionnaire and the men's questionnaire. These were used to collect information from men and women between the ages of 15-64 years.

In selecting which country to investigate, the availability of data was the primary consideration for inclusion in this study. While most countries have tobacco-related questions in their iterations of the DHS, only 36 of these surveys also had questions from the health expenditure module of the DHS and in selected years. Out of these only eight sub-Saharan

African countries have this data available, three of which have data older than 2010. Namibia is the only one of the remaining five countries that is English-speaking and will be the focus of this study.

2.2 Measurement

The following variables will be generated and used for analysis.

2.1.1 Smoking intensity

The men's and women's questionnaires have the following questions of relevance to smoking in the study:

Q1005 - In the last 24 hrs how many cigarettes did you smoke?

The definition of smoking in this instance will thus be restricted to cigarette smoking, excluding other forms of tobacco use which are likely to be less prevalent and will provide a measure for the intensity of smoking.

2.1.2 Healthcare expenditure

Table 1 below provides a brief description of the available variables to be used in the calculation of various estimates of health expenditure.

Question number	Variable to calculate	Description
Q144	IPD health expenditure	Amount of money spent on treatment and services during most recent overnight stay for household member.
Q146	IPD health expenditure	Number of overnight stays in the last 6 months
Q150	OPD health expenditure	Amount of money spent on treatment and services without overnight stay

Q152	OPD health expenditure	Number of OPD visits in the last 4 weeks
Q153	OPD health expenditure	Number OPD visits in the last 4 weeks in which house hold money was spent

Q141 and Q147 will provide information on the number of admissions and outpatient incidences over a given period. Q144 and Q150 will provide information on the amounts of money spent for episodes of illness, also called out-of-pocket payments. Q145 and Q151 will be used to determine the types of ailments most commonly responsible for episodes of illness. Since the data will be annualized the data obtained from Q146 and Q152 will be used as a multiplier to accurately determine the annual number of illness episodes.

The outcomes of interest will be the health expenditure variables captured as out-patient disease (OPD) expenditure incurred in the last 4 weeks and in-patient disease (IPD) expenditure incurred in the last 6 months. The calculations of expenditures will be done as follows:

- Annual OPD health expenditure = (Number of OPD visits in the last 4 weeks x Cost of the health care) x 13
- Annual IPD health expenditure = (Number of overnight stays in the last 6 months x Cost for the stay) x 2
- Total annual health expenditure = Annual OPD health expenditure + Annual health expenditure

All amounts are presented in Namibian Dollars (NAD) and will be converted to USD at the average exchange rate for 2013.

2.1.3 Socioeconomic status

The DHS country-specific wealth index will be used to measure socioeconomic status. The index has been shown to be consistent with income and expenditure measures with respect to inequalities in household income, health services and health outcomes (37). It is constructed using household asset data, dwelling characteristics and takes into account rural-urban differences in these characteristics. The DHS uses a principal components analysis method to assign indicator weights for the wealth index. The index is reported as both a standardized score factor and as a quintile. For this study the wealth index reported as quintiles will be used.

2.3 Statistical methods

2.3.1 Model specification

Multiple linear regression will be used to estimate the effect of smoking intensity, among other factors, on annual OPD health expenditure, annual IPD health expenditure and total health expenditure. Thus three models will be estimated and can be generally represented as:

$$y_i = \alpha_i + \beta_i x_i + u$$

Where y_i is the dependent variable for the different models as follows:

Model 1 – Annual OPD health expenditure;

Model 2 – Annual IPD health expenditure;

Model 3 – Total health expenditure.

x_i represents the explanatory variables in the model while α_i and β_i represent the coefficients to be estimated, and u is the error term. A list of the dependent and potential explanatory variables to be used is provided in Table 1 below.

2.3.2 Instrumental variable regression

Due to the possibility of endogeneity of the smoking intensity variable, an instrumental variable approach will be adopted. Endogeneity can arise due to its correlation with important unobserved regressors that have been omitted or if the outcome variable has a causal impact on smoking intensity (i.e., reverse causality) (38).

In order to use this method, an observable variable z_I , will need to be identified that is not a part of the original equation below:

$$y_0 = \beta_0 + \beta_1 y_1 + \beta_2 x_1 + \beta_3 x_2 + u$$

Where, y_1 is an endogenous variable and u is the error term, such that $\text{cov}(y_1, u) \neq 0$.

The instrument, z_I , would need to satisfy two main criteria:

1. z_I , must be uncorrelated with u with $\text{Cov}(z_I, u) = 0$

In other words, z_I must be exogenous.

2. z_I must be partially correlated with y_1 once the other exogenous variables, x_1, \dots, x_{k-1} are netted out.

This instrumental variable, z_I , can then be used in a two-stage least squares (2sls) regression to estimate the parameters.

In addition to this, the Hausman and Durbin-Wu-Hausman tests for endogeneity and the weak instruments tests will be conducted to ensure suitability of the selected instrument.

Table 2 below provides a list of the potential variables to be used in the analysis.

Table 2. List of variables

Dependent variables	Description
<i>Annual OPD health exp.</i>	Total annual health expenditure spent on out-patient disease (OPD) consultations (continuous variable)
<i>Annual IPD health exp.</i>	Total annual health expenditure spent on in-patient disease (IPD) overnight stays (continuous variable)
<i>Total annual health exp.</i>	Total annual health expenditure spent on either IPD or OPD (continuous variable)
Explanatory variables	Description
<i>hv025</i>	Type of place of residence (1=Urban; 2= Rural)
<i>hv104</i>	Sex of household member (1= Male; 2= Female)
<i>hv105</i>	Age (continuous variable)
<i>hv106</i>	Highest level of education attained (0= No education/pre-school; 1= Primary; 2= Secondary; 3= Tertiary)
<i>hv115</i>	Current marital status (0= Never married; 1= Married; 3=Widowed or divorced)
<i>hv270</i>	Wealth Index (1=Poorest; 2=Poorer; 3=Middle; 4=Richer; 5=Richest)
Instrumental variable	
<i>hv252</i>	Frequency at which household members smoke inside the house

2.3.3 Measuring the distribution smoking intensity across SES

There are several methods used to examine disparities in the distribution of a particular variable across people from different socioeconomic strata. The concentration curve will be used for determining the inequality of smoking intensity across the DHS wealth index quintiles. The CC curve typically shows the cumulative share of the variable of interest accounted for by cumulative shares of individuals ranked from poorest to richest. The figure below is an example of a concentration curve and shows a concentration curve that lies above the line of equality or the 45-degree line. This may show a pro-poor distribution of the variable of interest or it may lie below the line of equality to depict a pro-rich distribution. However, the interpretation of pro-poor and pro-rich distributions requires consideration of the parameter being measured. If a negative parameter is being measured, such as the number of birth defects, then a curve above the line of equality would mean the majority of cases are concentrated among the poor and this would be not be considered pro-rich, but rather pro-rich. Alternatively, if the parameter of interest is a positive one, such as access to education facilities, then a concentration curve above the line of equality would be pro-poor and conversely a concentration curve below the line of equality would be pro-rich.

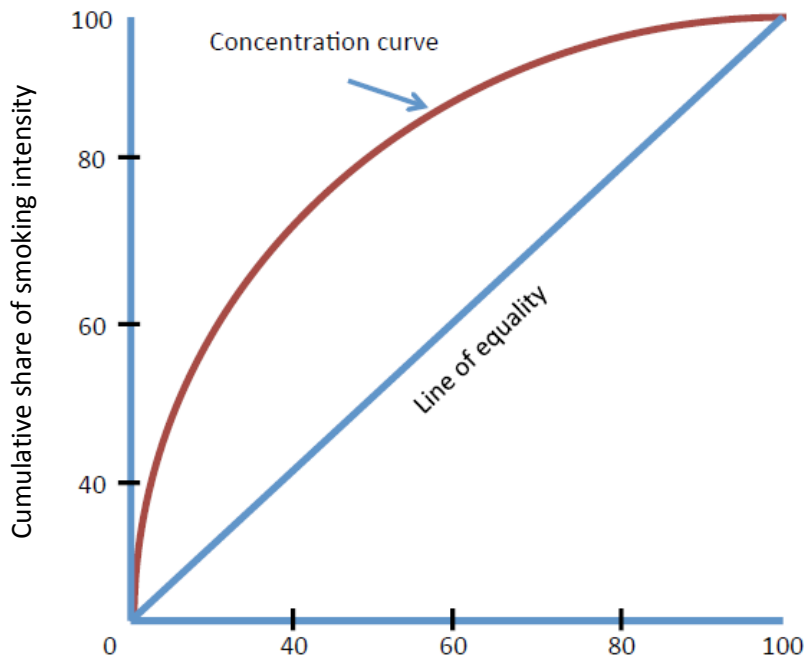


Figure 1. Concentration curve of smoking intensity

To further establish the magnitude of inequality, the study will compute the concentration index which is related to the concentration curve. It is defined as twice the area between the concentration curve and the line of equality and takes on values between -1 and +1. These values however also warrant careful interpretation, depending on what is being measured, in order to determine what constitutes a pro-poor versus a pro-rich distribution. For instance, in measuring inequality in infant mortality, a negative concentration index would imply a concentration of this parameter among the poor which is not “pro-poor”. Conversely, a negative concentration index when measuring inequality in health care utilization, would be considered to be pro-poor. The same is true for a positive concentration index, i.e. it would be considered pro-poor if Cumulative share of population from poorest to wealthiest \rightarrow infant mortality and pro-rich if health care utilization is the parameter of interest. The concentration index can be calculated as follows:

$$C = \frac{2\text{cov}(y_i, R_i)}{\mu}$$

where, y_i is smoking intensity, R_i is the fractional rank of individual i in the distribution of socioeconomic position and μ is the mean of y_i .

Apart from a visual inspection of the concentration curve, and the concentration index, a formal statistical test of dominance will be conducted in order to make appropriate inferences. This study will use the Multiple Comparison Approach (MCA) decision rule to determine if there are statistically significant differences between the concentration curve and the line of equality at 19 evenly spaced quantiles (39).

2 Analysis plan

All data cleaning, exploration and analysis will be done using statistical software, Stata 13 (40). The *ivregress* command will be used for the IV regression while tests will use the *estat endog* and *estat firststage* commands. For the concentration index and concentration curve, the study will use *concindc* module developed by Zhuo (Adam) Chen based on Kakwani et al to calculate them (41,42)

3 Ethic

3.1 Description of risks

As data being used will be secondary, no specific risks are anticipated for the participants. No direct benefits will accrue to the individuals that participated in the original survey. However, a societal gain may be obtained through the additional knowledge gained from this study. It is anticipated that the results may provide a better understanding of how tobacco use affects health-related expenditure at the household level and provide a starting point for how to address such issues in the countries being analysed.

3.2 Informed consent process

DHS is in the public domain, consequently individual consent will not be sought from the participants in the original survey country. Access to the datasets will be obtained from the DHS program coordinators through their website.

4 Stakeholders, reporting and dissemination

The findings from the study will be communicated through journal article and policy brief publications that form part of the requirements of the MPH Thesis. The journal article will be submitted to an appropriate peer-review journal and the thesis will be accessible via UCT library services.

5 Logistics

5.1 Timeline

The study is expected to take three months to complete as follows:

Activity	Estimated time
Protocol development	2 weeks
Data cleaning and analysis	4 weeks
Structured literature review	6 weeks
Journal manuscript	3 weeks
Policy brief	2 week
Final draft revisions	3 weeks

5.2 Budget

The budget for this study is outlined below:

Item	Description	Amount
Stationary	Printing, binding, pens and paper	R2,500
Transport	Domestic travel	R1,000
Communication	Internet and phone calls	R500
Total		R4,000

6 References

1. Ekpu, Brown A. The Economic Impact of Smoking and of Reducing Smoking Prevalence: Review of Evidence. *Tob Use Insights* [Internet]. 2015 Jul;1. Available from: <http://www.la-press.com/the-economic-impact-of-smoking-and-of-reducing-smoking-prevalence-revi-article-a4943>
2. World Health Organisation. The economic and health benefits of tobacco taxation. 2015.
3. Network of African Science Academies. Preventing a tobacco epidemic in Africa: A call for effective action to support health, social and economic development. Nairobi, Kenya; 2014.
4. African Union. The impact of tobacco use on health and socio-economic development in Africa. 2013.
5. Guindon GE, Guindon GE, Boisclair D, Boisclair D. Past, Current and Future Trends in Tobacco Use. *Population* (English Edition). 2003.
6. Hosseinpoor AR, Parker LA, Tursan d'Espaignet E, Chatterji S. Social determinants of smoking in low- and middle-income countries: Results from the world health survey. *PLoS One*. 2011;6(5).
7. Pampel F. Tobacco use in sub-Saharan Africa: Estimates from the demographic health surveys. *Soc Sci Med* [Internet]. 2008;66(8):1772–83. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0277953607006545>
8. Namibia Ministry of Health and Social Services. Demographic and Health Survey: Namibia. Windhoek; 2014.
9. World Health Organization (WHO). Non communicable Diseases Country Profiles

- [Internet]. Genève : WHO Press, 2014. 2014. Available from:
http://www.who.int/nmh/countries/ben_en.pdf?ua=1
10. Republic of Namibia Ministry of Health and Social Services. Namibia 2012/13 Health Accounts Report. Windhoek; 2015.
 11. Xu K, Saksena P, Jowett M, Indikadahena C, Kutzin J, Evans DB. Exploring the thresholds of health expenditure for protection against financial risk, Background Paper, No 19. 2010;22.
 12. U.S. Department of Health and Human Services. The health consequences of smoking—50 years of progress: A report of the Surgeon General [Internet]. Smoking and Health. Atlanta, GA; 2014. Available from: <http://ash.org/wp-content/uploads/2014/01/full-report.pdf%5Cnhttp://www.legacyforhealth.org/content/download/4428/62627/file/Abrams.SurGenReport.50thAnniv.2.5.14.FIN.pdf>
 13. U.S. Department of Health and Human Services. The Health Consequences of Involuntary Exposure to Tobacco Smoke A Report of the Surgeon General. Atlanta, GA; 2006.
 14. Sala-i-Martin X. 4 On the Health-Poverty Trap. Health and economic growth: Findings and policy implications. MIT Press; 2005. 95 p.
 15. Jauch H. Economic Perspectives on Global Sustainability Poverty , Unemployment and Inequality in Namibia Poverty , Unemployment and Inequality in Namibia. 2013;(2012).
 16. UNDP UNDP. Human Development Report 2015 Work for Human Development. 2015;288. Available from:

http://hdr.undp.org/sites/default/files/2015_human_development_report_1.pdf

17. Thompson ME. Estimating the Health Care Costs of Smokers. *Can J Public Heal.* 1983;74(3):183–90.
18. Leu RE, Schaub T. More on the impact of smoking on medical care expenditures. *Soc Sci Med.* Pergamon; 1985;21(7):825–7.
19. Leu RE, Schaub T. Does smoking increase medical care expenditure? *Soc Sci Med.* Elsevier; 1983;17(23):1907–14.
20. Rice DP, Hodgson TA, Sinsheimer P, Browner W, Kopstein N, Rice DP, et al. The Economic Costs of the Health Effects of Smoking, 1984. *Milbank Q.* 1986;64(4):489–547.
21. World Health Organization. Assessment of the Economic Costs of Smoking. *Economics of Tobacco Toolkit.* 2011.
22. Hodgson T. Cigarette smoking and lifetime medical expenditures. *Milbank Q* [Internet]. 1992;70(1):81–125. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/1588892>
23. Warner KE, Hodgson T a, Carroll CE. Medical costs of smoking in the United States: estimates, their validity, and their implications. *Tob Control.* 1999;8(3):290–300.
24. Kiiskinen U, Vartiainen E, Puska P, Pekurinen M. Smoking-related costs among in a 19-year individual follow-up. 2002;145–51.
25. Wacker M, Holle R, Heinrich J, Ladwig K-H, Peters A, Leidl R, et al. The association of smoking status with healthcare utilisation, productivity loss and resulting costs: results from the population-based KORA F4 study. *BMC Health Serv Res.* 2013;13:278.

26. Maciosek M V., Xu X, Butani AL, Pechacek TF. Smoking-attributable medical expenditures by age, sex, and smoking status estimated using a relative risk approach. *Prev Med (Baltim)* [Internet]. Elsevier Inc.; 2015;77:162–7. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0091743515001802>
27. Leartsakulpanitch J, Nganthavee W, Salole E. The economic burden of smoking-related disease in Thailand: A prevalence-based analysis. *J Med Assoc Thail.* 2007;90(9):1925–9.
28. Hayashida K, Imanaka Y, Murakami G, Takahashi Y, Nagai M, Kuriyama S, et al. Difference in lifetime medical expenditures between male smokers and non-smokers. *Health Policy (New York).* 2010;94(1):84–9.
29. Barendregt JJ, Bonneux L, van der Maas PJ. The health care costs of smoking. *N Engl J Med* [Internet]. 1997;337(15):1052–7. Available from: pm:9321534
30. Hiscock R, Bauld L, Amos A, Fidler JA, Munafò M. Socioeconomic status and smoking: A review. *Ann N Y Acad Sci.* 2012;1248(1):107–23.
31. Hill S, Amos A, Clifford D, Platt S. Impact of tobacco control interventions on socioeconomic inequalities in smoking: review of the evidence. *Tob Control* [Internet]. 2014;23(e2):e89-97. Available from: <http://tobaccocontrol.bmj.com/content/23/e2/e89.abstract>
32. Laaksonen M, Rahkonen O, Karvonen S, Lahelma E. Socioeconomic status and smoking: Analysing inequalities with multiple indicators. *Eur J Public Health.* 2005;15(3):262–9.
33. Hoang Anh PT, Thu LT, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. *Tob Control* [Internet]. 2014;25(1):96–100.

Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051821>

34. Yang L, Sung H-Y, Mao Z, Hu T, Rao K. Economic costs attributable to smoking in China: update and an 8-year comparison, 2000-2008. *Tob Control*. 2011;20(4):266–72.
35. Yao T, Huang J, Sung H-Y, Ong MK, Mao Z, Jiang Y, et al. Determinants of smoking-induced deprivation in China. *Tob Control* [Internet]. 2014;1–5. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051542>
36. Verguet S, Gauvreau CL, Mishra S, MacLennan M, Murphy SM, Brouwer ED, et al. The consequences of tobacco tax on household health and finances in rich and poor smokers in China: an extended cost-effectiveness analysis. *Lancet Glob Heal* [Internet]. 2015;3(4):e206–16. Available from: <http://www.thelancet.com/article/S2214109X15700951/fulltext>
37. Rutstein O.S. and Johnson K. DHS Comparative Reports No.6: The DHS Wealth Index. In 2004.
38. French, Michael T., Popovici I. That instrument is lousy! In search of agreement when using instrumental variables estimation in substance use research. *Health Econ* [Internet]. 2011 Jan;20(2):127–46. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21959306>
39. O’Donnell O, Doorslaer E Van. Analyzing Health Equity Using Household Survey Data,. Washington [Internet]. ... Health Equity Using 2008. 1-12 p. Available from: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Analyzing+Health+Equity+Using+Household+Survey+Data#5>

40. StataCorp. Stata Statistical Software: Release 13. Vol. 102, The Economic Journal. College Station, TX: StataCorp LP; 2013.
41. Kakwani A; van Doorslaer, E. NW. Socioeconomic Inequalities in Health: Measurement, Computation and Statistical Inference. *J Econom.* 1997;77(1):87–104.
42. Chen Z. CONCINDC: Stata module to calculate concentration index with both individual and grouped data. 2007.
43. World Health Organization. WHO global report on trends in prevalence of tobacco smoking 2015 [Internet]. WHO Magazine. 2015. Available from: http://apps.who.int/iris/bitstream/10665/156262/1/9789241564922_eng.pdf?ua=1
44. Eriksen M, Mackay J, Schluger N, Gomeshtapeh FI, Drope J. The Tobacco Atlas Fifth Edition. 2015.
45. Alavanja M, Baron JA, Brownson RC, Buffler PA, DeMarini DM, Djordjevic M V., et al. Tobacco smoke and involuntary smoking. *IARC Monogr Eval Carcinog Risks to Humans.* 2004;83:1–1413.
46. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease: An update. *J Am Coll Cardiol.* 2004;43(10):1731–7.
47. Powell JT. Vascular damage from smoking: disease mechanisms at the arterial wall. *Vasc Med.* 1998;3:21–8.
48. Doll R, Hill AB. Smoking and Carcinoma of the Lung. *BMJ* [Internet]. 1950 Sep 30;2(4682):739–48. Available from: <http://www.bmj.com/cgi/doi/10.1136/bmj.2.4682.739>
49. Doll R, Hill AB. Study of the Aetiology of Carcinoma of the Lung. *Br Med J* [Internet]. 1952;2(4797):1271–86. Available from:

<http://www.bmj.com/cgi/doi/10.1136/bmj.2.4797.1271>

50. Doll R, Hill AB. The Mortality of Doctors in Relation to Their Smoking Habits. *Br Med J*. 1954;1(4877):1451–5.
51. Royal College of Physicians of London. Smoking and health. Summary of a report of the Royal College of Physicians of London on smoking in relation to cancer of the lung and other diseases. Vol. 76, Pitman Medical Publishing. 1962. p. 234–6.
52. Stanhope B-J, Burdette WJ, Cochran WG, Farber E, Fieser LF, Furth J, et al. Report of the Advisory Committee to the Surgeon General of the Public Health Service [Internet]. ... , Education and Welfare, Public Health Service 1964. Available from: http://profiles.nlm.nih.gov/NN/B/B/M/Q/_/nnbbmq.ocr
53. U.S. Department of Health and Human Services. How Tobacco Smoke Causes Disease The Biology and Behavioral Basis for Smoking-Attributable Disease A Report of the Surgeon General How Tobacco Smoke Causes Disease : The Biology and Behavioral Basis for Smoking-Attributable Disease A Report of the Surgeon. 2010.
54. Strulovici-Barel Y, Omberg L, O’Mahony M, Gordon C, Hollmann C, Tilley AE, et al. Threshold of biologic responses of the small airway epithelium to low levels of tobacco smoke. *Am J Respir Crit Care Med*. 2010;182(12):1524–32.
55. World Health Organization. Protection from Exposure to Second-hand Tobacco Smoke. Policy Recommendations. 2007.
56. Hosseinpoor AR, Parker LA, Tursan d’Espaignet E, Chatterji S. Socioeconomic Inequality in Smoking in Low-Income and Middle-Income Countries: Results from the World Health Survey. *PLoS One*. 2012;7(8).
57. Hajizadeh M, Nandi A. The socioeconomic gradient of secondhand smoke exposure in

- children: evidence from 26 low-income and middle-income countries. *Tob Control* [Internet]. 2016 Jun 16;tobaccocontrol-2015-052828. Available from: <http://tobaccocontrol.bmj.com/lookup/doi/10.1136/tobaccocontrol-2015-052828>
58. Gartner CE, Hall WD. Is the socioeconomic gap in childhood exposure to secondhand smoke widening or narrowing? *Tob Control*. 2012;1–6.
 59. Miller VP, Ernst C, Collin F. Smoking-attributable medical care costs in the USA. *Soc Sci Med*. 1999;48(3):375–91.
 60. Miller LS, Zhang X, Rice DP, Max W. State estimates of total medical expenditures attributable to cigarette smoking, 1993. *Public Health Rep* [Internet]. 1998;113(5):447–58. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/18075245>
 61. Miller LS, Zhang X, Novotny T, Rice DP, Max W. State estimates of Medicaid expenditures attributable to cigarette smoking, fiscal year 1993. *Public Health Rep*. 1998;113(2):140–51.
 62. World Health Organization. WHO guide to identifying the economic consequences of disease and injury [Internet]. 2009. Available from: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:WHO+GUIDE+TO+IDENTIFYING+THE+ECONOMIC+CONSEQUENCES+OF+DISEASE+AND+INJURY#0>
 63. Rice DP. Estimating the cost of illness. *Am J Public Health Nations Health* [Internet]. 1967;57(3):424–40. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1227175&tool=pmcentrez&rendertype=abstract>
 64. Jo C. Cost-of-illness studies: concepts, scopes, and methods. *Clin Mol Hepatol*

- [Internet]. 2014;20(4):327–37. Available from:
[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4278062&tool=pmcentrez
&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4278062&tool=pmcentrez&rendertype=abstract)
65. Kang HY, Kim HJ, Park TK, Jee SH, Nam CM, Park HW. Economic burden of smoking in Korea. *Tob Control*. 2003;12(1):37–44.
 66. Max W, Rice DP, Sung H-Y, Zhang X, Miller L. The economic burden of smoking in California. *Tob Control* [Internet]. 2004;13(3):264–7. Available from:
[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1747911&tool=pmcentrez
&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1747911&tool=pmcentrez&rendertype=abstract)
 67. Wendy M. The financial impact of smoking on health-related costs: A review of the literature [Internet]. Vol. 15, *American Journal of Health Promotion*. 2001. p. 321–31. Available from: <http://www.scopus.com/inward/record.url?eid=2-s2.0-0343961984&partnerID=tZOtx3y1>
 68. Larg A, Moss JR. Cost-of-illness studies: A guide to critical evaluation. *Pharmacoeconomics*. 2011;29(8):653–71.
 69. Leistikow BN, Martin DC, Milano CE. Fire injuries, disasters, and costs from cigarettes and cigarette lights: a global overview. *Prev Med (Baltim)*. 2000;31(2 Pt 1):91–9.
 70. Chaloupka FJ, Warner KE. Chapter 29 The economics of smoking. In: *Handbook of Health Economics* [Internet]. 2000. p. 1539–627. Available from:
<http://linkinghub.elsevier.com/retrieve/pii/S1574006400800426>
 71. Pampel FC, Denney JT. Cross-National Sources of Health Inequality: Education and Tobacco Use in the World Health Survey. *Demography*. 2011;48(2):653–74.

72. Li DX, Guindon GE. Income, income inequality and youth smoking in low- and middle-income countries. *Addiction*. 2013;108(4):799–808.
73. Palipudi KM, Gupta PC, Sinha DN, Andes LJ, Asma S, McAfee T. Social determinants of health and Tobacco use in thirteen low and middle income countries: Evidence from Global Adult Tobacco Survey. *PLoS One*. 2012;7(3).
74. Agrawal S, Karan A, Selvaraj S, Bhan N, Subramanian S V., Millett C. Socio-economic patterning of tobacco use in Indian states. *Int J Tuberc Lung Dis*. 2013;17(8):1110–7.
75. Ayo-Yusuf OA, Olufajo O, Agaku IT. Exposure to secondhand smoke and voluntary adoption of smoke-free home and car rules among non-smoking South African adults. *BMC Public Health* [Internet]. 2014;14(1):580. Available from: <http://www.biomedcentral.com/1471-2458/14/580>
76. Beltrán-Sánchez H, Thomas D, Teruel G, Wheaton F, Crimmins EM. Links Between Socio-Economic Circumstances and Changes in Smoking Behavior in the Mexican Population: 2002–2010. *J Cross Cult Gerontol* [Internet]. 2013 Sep 26;28(3):339–58. Available from: <http://link.springer.com/10.1007/s10823-013-9203-8>
77. Boing a F, Antunes JLF, de Carvalho MB, de Góis Filho JF, Kowalski LP, Michaluart P, et al. How much do smoking and alcohol consumption explain socioeconomic inequalities in head and neck cancer risk? *J Epidemiol Community Health*. 2011;65(8):709–14.
78. Ayo-Yusuf OA, Olutola BG, Agaku IT. Cigarette Smoking Trends and Social Disparities Among South African Adults, 2003–2011. *Nicotine Tob Res*. Oxford University Press; 2015;17(8):1049–55.

79. Efroymson D, Ahmed S, Townsend J, Alam SM, Dey a R, Saha R, et al. Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. *Tob Control*. 2001;10(3):212–7.
80. Pu C, Lan V, Chou Y, Lan C. The crowding-out effects of tobacco and alcohol where expenditure shares are low: Analyzing expenditure data for Taiwan. *Soc Sci Med* [Internet]. 2008 May;66(9):1979–89. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0277953608000221>
81. Nonnemaker J, Sur M. Tobacco expenditures and child health and nutritional outcomes in rural Bangladesh. *Soc Sci Med*. 2007;65(12):2517–26.
82. McGhee SM, Ho LM, Lapsley HM, Chau J, Cheung WL, Ho SY, et al. Cost of tobacco-related diseases, including passive smoking, in Hong Kong. *Tob Control* [Internet]. 2006 Apr;15(2):125–30. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/16565461>
83. Bundhamcharoen K, Aungkulanon S, Makka N, Shibuya K. Economic burden from smoking-related diseases in Thailand. *Tob Control*. 2015;1–6.
84. Arrieta O, Quintana-Carrillo RH, Ahumada-Curiel G, Corona-Cruz JF, Correa-Acevedo E, Zinser-Sierra J, et al. Medical care costs incurred by patients with smoking-related non-small cell lung cancer treated at the National Cancer Institute of Mexico. *Tob Induc Dis* [Internet]. 2014;12(1):25. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4316797&tool=pmcentrez&rendertype=abstract>
85. Sturm R, An R, Maroba J, Patel D. The effects of obesity, smoking, and excessive alcohol intake on healthcare expenditure in a comprehensive medical scheme. *South African Med J*. 2013;103(11):840–4.

86. Lwegaba A. Excess healthcare cost associated with a low smoking prevalence, Barbados. *West Indian Med J*. 2004;53(1):12–6.
87. Arredondo A, Carrillo C, Zuñiga A. Economic burden of expected epidemiological changes in diseases related to tobacco, Mexico. *Rev Saude Publica*. 2007;41(4):523–9.
88. Hoang Anh PT, Thu LT, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. *Tob Control* [Internet]. 2016;25(1):96–100. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051821>
89. World Health Organization. WHO report on the global tobacco epidemic: Raising taxes on tobacco. *World Heal Organ* [Internet]. 2015;52–3. Available from: www.who.int/tobacco
90. Vermeulen F. Do smokers behave differently? A tale of zero expenditures and separability concepts. *Econ Bull*. 2003;4(1).
91. Warner DO, Borah BJ, Moriarty J, Schroeder DR, Shi Y, Shah ND. Smoking status and health care costs in the perioperative period: a population-based study. *JAMA Surg* [Internet]. 2014;149(3):259–66. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4332384&tool=pmcentrez&rendertype=abstract>
92. Government of the Republic of Namibia. *Government Gazette of the Republic of Namibia*. 2014.
93. Government of the Republic of Namibia. *Government Gazette of the Republic of Namibia*. 2010 p. 1–26.
94. Benson FE, Kuipers MAG, Nierkens V, Bruggink J, Stronks K, Kunst AE.

- Socioeconomic inequalities in smoking in The Netherlands before and during the Global Financial Crisis : a repeated cross-sectional study. 2015;1–12.
95. Sturm R et al. The effects of obesity, smoking and excessive alcohol intake on health care expenditures in a comprehensive medical scheme. *South African Med J*. 2013;103(11):840–4.
 96. Neubauer S, Welte R, Beiche A, Koenig H-H, Buesch K, Leidl R. Mortality, morbidity and costs attributable to smoking in Germany: update and a 10-year comparison. *Tob Control*. 2006;15(6):464–71.
 97. Bolin K, Lindgren B. Smoking, healthcare cost, and loss of productivity in Sweden 2001. *Scand J Public Health* [Internet]. 2007;35(2):187–96. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17454923>
 98. Hassmiller KM, Warner KE, Mendez D, Levy DT, Romano E. Nondaily Smokers: Who Are They? *Am J Public Health*. 2003;93(8):1321–7.
 99. Lloyd-Richardson EE, Papandonatos G, Kazura A, Stanton C, Niaura R. Differentiating stages of smoking intensity among adolescents: Stage-specific psychological and social influences. *J Consult Clin Psychol* [Internet]. 2002;70(4):998–1009. Available from: <http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-006X.70.4.998>
 100. Lopez a. D, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. Vol. 3, *Tobacco control*. 1994. p. 242–7.
 101. Thun M, Peto R, Boreham J, Lopez AD. Stages of the cigarette epidemic on entering its second century. *Tob Control* [Internet]. 2012;21(2):96–101. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22345230>

Structured Literature Review

B. Theoretical and methodological review

1. Introduction

Globally, the World Health Organization (WHO), estimated that tobacco use accounted for about 6 million deaths annually in 2015, most of them premature (43). The estimate included about 600,000 deaths from effects due to exposure to second-hand smoke. However, tobacco use is not homogeneous but diverse, with products ranging from more traditional pipes, hand-rolled leaf and forms of chewing tobacco to more modern products such as e-cigarettes which emit a nicotine vapour through a nicotine delivery system. The most commonly used tobacco product globally, however remains the manufactured cigarette with an estimated 5.8 trillion cigarettes smoked worldwide in 2014 alone (44).

The composition of cigarette smoke is known to be a particularly toxic mix of over 7,000 chemicals, including at least 69 known carcinogens (45). As a general convention cigarette smoke is divided into two parts, namely a tar or particulate phase and a gas phase. The difference between the two arises when a smoke stream is passed through the Cambridge glass-fibre filter – the filter retains 99.9% of all particulate matter, known as the tar phase while the remainder passes through the filter and is known as the gas phase (46). Furthermore, a distinction is made between mainstream smoke, which is cigarette smoke drawn through the tobacco to an active smoker's mouth, and side-stream smoke, emitted from the burning end of a cigarette. Mainstream cigarette smoke contains 8% tar and 92% gaseous ingredients, while second-hand smoke typically contains 85% side-stream smoke and 15% of mainstream smoke exhaled by active smokers (46). Importantly, among the known ingredients in cigarette smoke, nicotine, a component of the tar phase, is the most addictive substance (46,47).

The proceeding sections will first introduce the theoretical framework linking smoking with ill-health. This will be followed by an examination of the relationship between smoking, health inequality and health expenditure. Finally, the paper will review the economic cost of smoking.

2. Smoking and health

Tobacco use and its impact on various health outcomes has been investigated for over half a century. Since the seminal work of Doll and Hill in the 1950's (48–50) which established an association between individual smoking habits and lung cancer, interest in the impact smoking has on the population expanded from health outcomes on smokers to the impact of second-hand tobacco smoke on non-smokers. This work, along with others done during that period culminated in the landmark reports by the Royal College of Physicians in the United Kingdom (51) and the US Surgeon General's Report² on smoking and health (52) both of which concluded that a causal relationship existed between smoking and lung cancer. The US Surgeon General's Advisory Committee further concluded that cigarette smoking caused both lung and laryngeal cancer, and was the most important cause of bronchitis (52).

Over the next fifty years, researchers across the world linked active smoking to increased risk for various non-communicable diseases (NCDs) such as coronary heart disease (CHD), chronic obstructive lung disease, peripheral vascular disease, abdominal aortic aneurysm, stroke and infertility (4,12,53). In addition, passive smoking or exposure to second-hand smoke has been causally linked to stroke, nasal irritation, lung cancer, coronary heart disease and low birth weight in new-borns (12). In fact, evidence suggests that there is no safe level of exposure to second hand smoke, further highlighting the substantial health risks even to those that do not smoke (54,55).

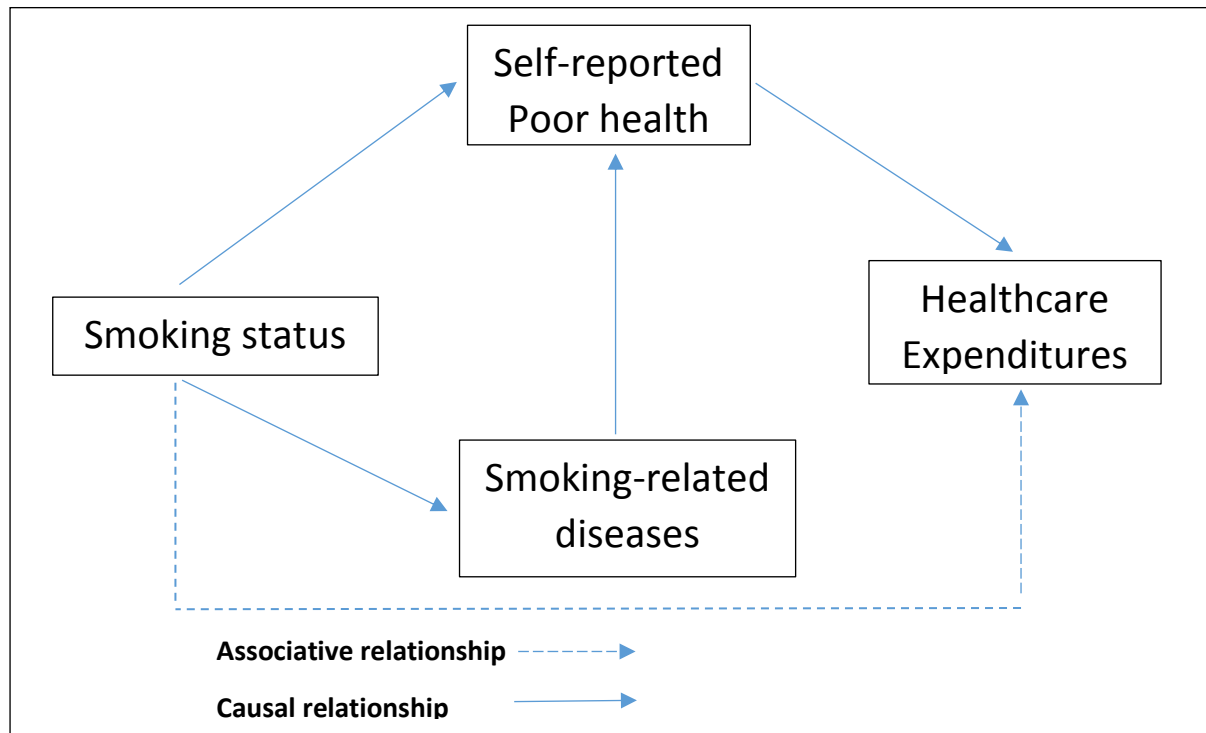
² The report, titled "Smoking and Health: Report of the Advisory Committee of the Surgeon General of the Public Health Service" was released on 11th January 1964 and compiled evidence from over 7,000 articles relating smoking and disease available at the time.

2.1 Smoking, health inequality and health expenditure

Large disparities have been noted in tobacco use across racial or ethnic groups, gender, socioeconomic status, education level and even regions (31,32,56). Furthermore, exposure of the most disadvantaged groups to second hand smoke remains a growing concern in both developed and developing countries (57,58). The concentration of smoking prevalence in lower socioeconomic groups contributes to a cycle of disease and impoverishment whereby higher smoking rates lead to poor health status and higher smoking-related disease prevalence in the sub-populations least able to pay for health services.

A recent structural-form econometric model developed by Miller and others has been used in the literature as an alternative to the epidemiological models for estimating the cost of smoking (59–61). The model provides a causal and associative link between smoking and health expenditures in terms of both “biological effects” and “non-biological effects”. The rationale for this framework is that smoking status impacts an individual’s likelihood to have smoking-related diseases, report poorer health status and ultimately affecting health expenditures (21). Through this “biological effect”, smokers are generally expected to have higher health expenditures. The “non-biological effects” in contrast, takes into account the fact that smokers may have higher and lower healthcare expenditures for reasons not directly related to the health condition. For instance, smokers may have lower health expenditures depending on how their risk-taking profiles influences their health seeking behaviour (23). The causal mechanism by which smoking status affects health expenditures is depicted in Figure 1 below.

Figure 1 – Conceptual framework for the causal and associative relationship between



smoking and healthcare expenditure

Source: World Health Organization (2011)

2.2 The economic cost of smoking

The economic burden imposed by smoking has generally been quantified in terms of its overall impact at the macro-economic or societal level. Some of the lesser known models developed in this respect, considered the long-term dynamic impact on changes in demographic composition, disease formation, reduced financial investment and human capital formation and the interaction of economic agents through a comprehensive flow-of-income framework (21). Models that fall within this domain include the economic growth model, the calibration model, the computable general equilibrium (CGE) model and the full income model (62). The first three models estimate the impact of disease, in general, on Gross Domestic Product (GDP) and/or GDP growth while the fourth model uses a willingness-to-pay approach to estimate impact on economic welfare. These models typically

have high data requirements and involve complex model estimation making them difficult and unpopular for widespread use.

Most cost of smoking studies have used the cost-of-illness approach developed by Rice and others (21,63). This approach adopts a macroeconomic perspective to analyse the aggregate impact of smoking across different economic agents. The costs are recognized, identified, listed, measured and valued as part of the approach and broadly divided into direct and indirect costs (64). Direct costs consist of both healthcare costs and non-healthcare costs. The former include all medical expenditure relating to diagnosis, treatment and other expenses related to healthcare while the latter include expenses related to the consumption of non-healthcare resources such as transportation, household expenditure on items such as food for the hospitalised patient and property losses, such as when property is sold to cover medical expenses. Indirect costs refer to the productivity loss suffered by the individual, family or society due to reduced time at work through morbidity or mortality (21,64).

Conceptually, the economic cost of illness is defined as the difference between healthcare or other costs incurred due to smoking and the healthcare and other costs that would have been incurred regardless of smoking (21). In other words, the cost of smoking refers to the additional costs incurred by society as a result of smoking. Thus, although estimation of the cost of smoking uses the cost of illness approach, it requires one to identify direct and indirect costs due to smoking-related illnesses. Studies of this kind can thus be divided into two using this attributable-risk method – a prevalence-based and an incidence-based approach. The distinction in the set of estimates generated results from how the epidemiological data are used.

The prevalence-based approach compares the sum of excess costs of smoking-related diseases and deaths incurred by current and former smokers to costs incurred by never

smokers (21). Costs are estimated based on smoking-related illnesses manifested in that year but caused by cumulative exposure to tobacco smoke over previous years. The approach estimates economic costs for newly diagnosed patients with smoking related diseases, those in advanced stages and those who died as a result of smoking-related illnesses, irrespective of when they may or may not have quit smoking. These annual costs of smoking are estimated from cross-sectional data and the method is sometimes referred to as the cross-sectional approach. Several studies have used this approach to estimate cost of smoking over the last three decades (20,65,66).

The second method of using the epidemiological data is the incidence-based approach which estimates the expected additional costs as a result of smoking-related illness in a group of smokers compared to never smokers over their lifetimes (21). Thus the economic costs are the excess lifetime costs per smoker compared to a never smoker as a result of smoking-related diseases if they continue to smoke throughout their lifetime at the current smoking rate. The expected lifetime costs are discounted to convert future values to present values and are added up as a series of discounted annual excess costs over the lifetime taking into account differing life expectancy on costs between the two groups. Importantly, a possible trade-off exists between above-average annual healthcare expenditures for smokers and the additional years of healthcare expenditure for never-smokers due to longer life expectancy. Premature death due to smoking-related illness has the seemingly perverse economic benefit of reducing the number of years that people can consume healthcare consequently avoiding some future healthcare costs. A potential saving from premature death is thus conceivable and some studies have attempted to estimate the “net cost” taking into account this “death benefit” (19,23,67). The incidence based approach, by design, estimates health costs using longitudinal data for smokers and never-smokers over their lifetimes. This requirement of tracked data over time has limited the frequency of its use in the literature.

The two approaches have their strengths and weaknesses. Prevalence-based cost of smoking studies, for instance, estimate past and present costs, but fail to provide any estimate of long-term consequences of the smoking-related illnesses over the lifetime of the smoker. They are therefore best suited to draw attention to smoking-related illnesses whose impact has been underestimated and to design cost containment policies allowing policy makers to make decisions based on information about where the highest costs are incurred. On the other hand, incidence based approaches estimate the present and future costs of smoking-related illnesses in a particular year. This makes it suitable for considering preventive measures and estimating the potential cost savings that would accrue or for analysing disease management protocols to make them more effective and efficient. Both methods are also particularly sensitive to the epidemiological stage of the diseases being considered. Thus, for ongoing health or social problems such as substance abuse, both approaches have similar estimates. However, health problems that are on the decline will likely result in underestimation of prevalence based estimates while emerging health problem likely results in overestimation of incidence based estimates if a latency phase exists (64).

Cost of illness studies further distinguish between top-down and bottom-up approaches for assessing costs. The top-down approach, also called the attributable-risk approach, measures the proportion of a disease at the aggregate population level that is due to exposure to the risk factor, in this case cigarette smoke (64). It estimates the fractions of resource use that should be allocated to each disease using the population-attributable fraction, which in turn are calculated from the relative risk of the disease or utilization of health care services for individuals with the disease (68). Unlike the aggregate approach, the bottom-up approach is person-based and assigns resource use and productivity losses due to a smoking-related illness to the individual. This method has an advantage over the top-down approach in that it can use statistical techniques to adjust for confounding, providing for more robust cost

associations. In addition, it is more suitable for complex conditions as it would be able to generate more comprehensive cost estimates.

A third approach uses econometric techniques to estimate the cost differentials between a cohort with the exposure or disease of interest and a cohort without it. The cohorts are matched by a series of regressions on various demographic and mediating factors. The method can estimate costs through a mean difference approach or a multi-stage regression approach. The first approach compares the mean costs incurred by each cohort to determine the incremental difference attributable to smoking (64). The multi-stage regression, in contrast, is conducted if there are large numbers of cases with zero costs and few cases with very high costs. A comparison of the coefficients from the regression analysis with the disease dummy variable to the regression estimates without the disease variable yields the incremental cost of the disease. This econometric method generally requires only one dataset and is the main advantage over the other methods of estimating costs.

In general, however, cost of smoking studies have been faulted on several fronts. A common criticism has been the omission of certain categories of smoking-related health care such as costs of treatment and death of burn victims from smoking-induced fires (69) or the cost related to perinatal care for low-birth weight babies of smoking mothers (70). In addition, very few studies have included costs related to treatment of diseases caused by second hand smoke exposure despite these costs being potentially substantial in places with high smoking rates. Notably, intangible costs were conspicuously excluded from cost of illness studies in general and, specifically from cost of smoking studies until the turn of the millennium. Intangible costs require valuation of the costs of pain and suffering of smoking-related victims and their families. However, the development of the concepts of Quality Adjusted life years (QALYs), Disability adjusted life years (DALYs) and other health-related quality of life estimates that take into account both the duration and quality of life associated with the

disease have opened new possibilities for developing a deeper understanding of the burden of smoking, beyond mere cost considerations.

The debate in estimating lifetime cost of smoking using net costs or gross costs in the incidence based approach has been raging for at least the last three decades (18,23,29). In general, cost of illness studies have been criticised for lacking consistency in methodology, relevance to policy and overall credibility. This intellectual debate remains far from settled and cost of illness studies have in fact garnered a growing interest among public health advocates and health care policy makers.

3. Empirical review

3.1 Objective

The objectives of this empirical review are to review the link between cigarette smoking and health inequality and how this is related to inequality in health expenditure. Studies on smoking and health have been done extensively for several decades. The majority of these studies were conducted in developed countries. This structured literature review, however, focusses on studies conducted in developing countries. While the studies conducted in developing countries are not many, they provide some insights of the socioeconomic disparities in smoking and health care costs. LMIC policymakers and decision makers are increasingly interested in evidence relevant to their local settings to which this study aims to make a contribution. These studies were divided into two categories, namely studies linking smoking to inequality in health and studies on the economic cost of smoking with a focus on health-related expenditures.

3.2 Reviewed studies

Six databases were searched – Africa-wide information, CINHAHL, SocINDEX with full text, Business Source Premier, Econlit and MEDLINE. The search results were filtered to only include studies done from the year 2000 to date and published in a peer-reviewed journal in English. The review covered the following aspects: the objectives of the studies, the measure of smoking used, measures of socioeconomic status used in the studies, analytical methods for the studies, findings and conclusions from these studies.

3.3 Inequality in smoking prevalence and smoking-related diseases

Studies that assessed the relationship between tobacco use and socioeconomic factors in this review included five multi-country cross-sectional studies (7,56,71–73), two single-country cross-sectional studies (74,75), one prospective cohort study (76) and one case-control study (77). The diversity of single-country studies range across studies conducted in Mexico (76), Brazil (77), India (74) and South Africa (78), while the number of countries included in the multi-country studies ranged from thirteen (73) to sixty-three (72) low and middle income countries (LMICs).

Table 1: Articles reviewed on disparities in smoking prevalence and smoking-related diseases among LMICs

Author(s), (year)	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method(s)	Findings/ Conclusions
Pampel F. (2008)	Setting: 14 sub-Saharan African countries Study type: Cross-sectional study	To describe the prevalence and social patterns of cigarette and tobacco use, in general, in 14 African countries.	- Urban residence - Occupation - Education - Age	- Smoking prevalence (Use cigarettes only; or use cigarettes and other tobacco products). - Smoking intensity (Number of cigarettes used in the last day).	-Multinomial logistic regression - Linear regression	Results for men show highest cigarette use among urban, less educated and lower status workers while results for women showed much lower prevalence but comparable social patterns of use.
Boing et al. (2010)	Setting: Brazil Study type: Case-control study	To assess the association between socioeconomic status (SES) and head and neck cancer in relation to alcohol and tobacco consumption	- Years of education - Occupation - Smoking status - Alcohol drinking	- Pharyngeal cancer - Oral cancer - Laryngeal cancer	- Unconditional logistic regression - Multivariate analysis using hierarchical framework of socioeconomic factors as distal and behavioural factors as proximal exposures.	Socioeconomic disparities in head and neck cancer were partially attributable to the distribution of tobacco and alcohol consumption across SES.
Pampel and Denney (2011)	Setting: 50 low and middle income countries	To test the argument that increasing educational disparities	- Smoking status - Years of education - Occupation	- Current smoking status (occasional and regular smokers)	Multilevel regression analysis: - Logistic regression	- Increases in national income and cigarette diffusion widen

Author(s), (year)	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method(s)	Findings/ Conclusions
	Study type: Cross-sectional study	in tobacco use and inequalities in health and premature mortality are associated with higher national income and more advanced cigarette diffusion.	- Standard of living measure		model at Level 1 - Level 2 equations assuming individuals are nested within nations.	educational inequalities in smoking among the young and men.
Hosseinpour et al. (2011)	Setting: 48 low and middle income countries Study type: Cross-sectional study	To assess demographic and socioeconomic determinants of current smoking in low and middle income countries.	- Highest education level - Rural or urban - Wealth quintile	- Current smoking status (Both daily and occasional smokers)	Multivariable logistic regression was used to assess the association between current smoking and demographic as well as socioeconomic factors.	- The highest smoking rate was observed among men in the lowest wealth quintile. - The odds of smoking increased with age until about 50 years for both men and women.

Author(s), (year)	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method(s)	Findings/ Conclusions
Li and Guindon (2012)	Setting: 63 low and middle income countries Study type: Cross-sectional study	To examine the relationships between income, income inequality and current smoking	- National GDP per capita - Gini coefficient - Decile dispersion ratio	- Current youth smoking status (smoked at least 1 cigarette in the last 1 month)	Estimated a three-level binary logistic multi-level model.	- Overall, income and income inequality exert a major influence on smoking behaviour in youth in LMICs. - There is a positive association between GDP and the odds of a young person smoking in an LMICs.
Palipudi et al. (2012)	Setting: 13 low and middle income countries Study type: Cross-sectional study	To examine the influences of socio-demographic determinants on current tobacco use.	- Place of residence - Knowledge of the harmful effects of smoking - Educational level - Wealth index	- Current smoking status (Use of any tobacco product either daily or occasionally)	Estimated a multiple logistic regression model	Significant trends showing: - decreasing smoking prevalence with increasing levels of education in 5 of 13 countries - decreasing prevalence of tobacco use with increasing wealth in 8 of 13 countries. - decreasing prevalence of tobacco use with increasing levels of knowledge of harmful effects of smoking in 8 of 13 countries.
Beltran-Sanchez et al. (2013)	Setting: Mexico Study type:	To examine the socioeconomic and	- Household expenditure	- Smoking initiation - Smoking cessation	- Model 1 estimated the odds of quitting relative	- Socioeconomic indicators are more

Author(s), (year)	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method(s)	Findings/ Conclusions
	Prospective cohort	demographic characteristics associated smoking initiation and quitting.	- Level of education - Demographic variables		to continuing to smoke among those who smoke - Model 2 estimates the odds of starting relative to non-smokers.	likely to predict the initiation of smoking than quitting smoking. - Urban residents are at higher risk of initiating smoking than rural residents, regardless of gender.
Agrawal et al. (2013)	Setting: India Study type: Cross-sectional study	To assess variations in associations between socioeconomic status and tobacco use across Indian States by tobacco type.	- Education level - Total household expenditure - Average educational level of adult household members	- Household tobacco use by type of product (smokeless tobacco, bidi or cigarette). - Volume of tobacco consumption by type of product (smokeless tobacco, bidi or cigarette).	Logistic regression and linear regressions models	- Increased household income was associated with a higher likelihood of cigarette use and higher volumes of cigarette and bidi use.
Ayo-Yusuf et al. (2015)	Setting: South Africa Study type: Cross-sectional study	To examine overall trends in cigarette smoking by socioeconomic status in South Africa between 2002-2011	- Smoking prevalence - Cigarettes smoked per day (CPD)	- Educational attainment	- Trends in smoking were assessed with estimates of annual percentage change (APC) - Disparities in smoking were assessed with relative concentration index (RCI)	- Decline in smoking prevalence was observed among those with no education, while an increase was observed among the most educated women over the same period. - The RCI by educational status significantly increased from 0.80

Author(s), (year)	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method(s)	Findings/ Conclusions
						(2003) to 1.35 (2007) to 1.94 (2011) indicating a narrowing of smoking disparities across the socioeconomic strata.

Pampel (2008) first attempted to describe the prevalence and patterns of tobacco use in fourteen sub-Saharan African countries before later collaborating on a similar, but much larger study (71). The first study analysed patterns of smoking prevalence and smoking intensity across various socioeconomic groups using data from Demographic Health Surveys (DHS). The measures of socioeconomic status (SES) used in this study were occupation and level of education attained, with a third proxy being geographical area of residence (rural or urban) – all as categorical variables. The study established that while smoking prevalence was lower for women than for men, they both exhibited similar social patterns of use, with the highest levels of consumption among urban dwellers, the less educated and lower status workers (7). On the other hand, the second study, in collaboration with Denney (71), included fifty LMICs and was one of the first such large-scale studies to assess the educational disparities in tobacco use and the associated inequalities in health. Drawing from the World Health Surveys (WHS), the study tested the argument that increasing educational differences in tobacco use, inequalities in health and premature mortality are associated with higher national income and more advanced cigarette diffusion. A multi-level logistic regression model was estimated with years of education, occupation and standard of living measures as SES variables. The results showed that the increase in national income and cigarette diffusion widened educational disparities, especially among men and the young.

These results were consistent with another multi-country study in the same year by Hosseinpoor and colleagues (6) which also found that smoking rates were highest among men in the lowest wealth quintile. In addition, Li and Guindon (2013) using Global Youth Tobacco Survey (GYTS) data found that there was a positive association between national income levels and the odds of a young person smoking in LMICs. Likewise, Palipudi and others (73) using data from the Global Adult Tobacco Survey (GATS) found that in five of the thirteen countries in their study, increasing levels of education were associated with

decreasing smoking prevalence, while in eight of the countries this decrease was associated with increasing wealth.

Agrawal and others (74) assessed the disparities in the association between socioeconomic status and tobacco use across Indian States. Using level of education as the main SES variable, they established that increased household income was associated with a higher likelihood of cigarette use as well as higher volumes of cigarette and *bidi*³ use. The study however used households as the unit of analysis and was thus limited in its ability to determine the validity of the results at individual level.

In a different study, Ayo-Yusuf and colleagues (78) assessed the distribution of smoking across educational attainment levels as a proxy for SES in South Africa. The study used data from three years of the South African Social Attitudes Survey (2003, 2007 and 2011) to estimate annual percentage changes in the smoking prevalence while disparities in smoking were assessed using the relative concentration index (RCI). A decline in the smoking prevalence was observed among those with no education while an increase was observed among women with the highest education attainment over the same period. This shift in socioeconomic inequality in smoking prevalence was reflected in the RCI estimated which increased from 0.80 in 2003 to 1.35 in 2007 and finally to 1.94 in 2011 indicating a narrowing of the disparity.

These cross-sectional studies all suffered similar limitations. Firstly, the kind of study design is only able to show the association of various SES variables with smoking prevalence or consumption. This does not necessarily infer a causal relationship between the variables being assessed. Secondly, with the exclusion of Pampel's study (7), the remaining studies (6,71,72) only assessed current smoking status, including frequent smokers with occasional

³ *Bidi* is a type of cheap cigarette made of unprocessed tobacco wrapped in leaves.

smokers, without taking into account changes in past smoking behaviour. Lastly, all the cross-sectional surveys used self-reported smoking status which can be underestimated in such surveys. It is a particularly important factor for the study by Li and Guindon (2013) which assessed youth smoking – generally considered to be socially undesirable.

Beltran-Sanchez and colleagues (2013) used a prospective cohort study design to examine the socioeconomic and demographic characteristics associated smoking initiation and quitting in Mexico. The study found that urban residents are at a higher risk of initiating smoking than rural residents, regardless of gender. Furthermore, socioeconomic indicators were found to better predict the initiation of smoking than smoking cessation. The main advantage of this type of design is that it allowed for temporal analysis of the associations. However, it did not measure any changes in smoking behaviour, such as smoking intensity, over the smoker's lifetime.

An earlier study by Boing et al. (2011), used a case-control design to investigate the socioeconomic disparities in head and neck cancer, linked to corresponding inequalities in tobacco and alcohol consumption. The study observed a higher risk of disease among those with lower education and those performing manual labour. The authors conclude that the differences observed in socioeconomic occurrence of neck and head cancer were partially attributable to the distribution of tobacco smoking and alcohol consumption. Importantly, the study tries to take the socioeconomic differences in smoking a step farther by assessing its association with the occurrence of two smoking-related cancers. The study design however has its limitations owing to risk of recall bias, misclassification due to self-reported behavioural history and limited generalizability of the data.

The studies presented consistently establish that tobacco use, in a diversity of settings, is closely but negatively associated with socioeconomic status, whether this is measured by

level of education attained, occupation, wealth index or even urban residence. Furthermore, the influence of levels of income on youth smoking is positive, such that it increases the likelihood of youth smoking. In other words, smoking prevalence appears to be highest among the poorest in the populations of many LMICs. These are also the most vulnerable equity groups, who are already prone to ill-health linked to poverty and least able to pay for healthcare services. These disparities in smoking prevalence and intensity thus portend a looming epidemic among many LMICs as the prevalence of smoking increases in these countries. However, in this review only one study goes further to establish a relationship between the disparities in smoking prevalence and the disparities in specific smoking-related diseases. This link can be extrapolated even farther to assess the link between smoking, ill-health and healthcare expenditure, whether at individual or at national levels. This generally constitutes the economic cost of smoking and will be the subject of the next section.

3.4 Smoking and health expenditures

Generally, the articles assessing the cost of smoking can be divided into two broad categories – those that assess the impact of tobacco expenditure on displacement of expenditure (the so called crowding-out effect) on other household goods and services (79–81), and second those that assess the impact of tobacco use on healthcare expenditure, either at individual, institutional or national level (33,82–87).

Table 2: Articles reviewed on the economic cost of smoking

Author(s), year	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method (s)	Findings/Conclusions
Efroymsen et al (2001)	Setting: Bangladesh Study type: Cross-sectional study	a) To investigate the extent of tobacco expenditures in Bangladesh; b) To compare expenditures in (a), above to potential investment in food and other essential items	- Tobacco use - Level of household income	- Tobacco use - Tobacco expenditures - Daily food consumption	Data were used to make comparisons of different expenditures and to calculate potential food purchases from tobacco expenditures. Calculations of potential food purchases and their caloric value were made for the comparison.	- The typical male smoker spends over five times, 18 times and 20 times as much on cigarettes as for house rent, health and education, respectively. - Tobacco expenditure per household represents 1.3% of total household expenditure in rural areas, 3.3% in urban areas and 1.4% for the whole country. - The poorest households were twice as likely to smoke as the wealthiest.
Lwegaba A (2004)	Setting: Barbados Study type: Prospective cohort with nested case control study	To estimate the tobacco-associated morbidity and hospital care costs.	Index of diseases and other chronic diseases with recorded smoking status	a) Cohort analysis: - Excess morbidity - Excess healthcare financial burden b) Case-control analysis: - Smoking exposure	a) Morbidity cohort analysis was used to measure incidence density, risk ratios, and preventive fraction b) Case control analysis was used to compute odds ratios for exposure.	- A smoker's hospital bill was found to be nearly two times (1.86 times) more than that for a non-smoker and five times more than government per capita health allocation. - Medical complications tended to be significantly more severe, multiple and with relatively poorer prognosis among smokers

Author(s), year	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method (s)	Findings/Conclusions
McGhee et al. (2006)	Setting: Hong Kong, China Study type: Cross-sectional design	To estimate the health-related costs of tobacco use from active and passive smoking	<ul style="list-style-type: none"> - Hospital admissions - Outpatient, emergency and GP visits - Use of nursing homes - Time lost from productive work 	<ul style="list-style-type: none"> - Cost of mortality due to active smoking (35 year and above) - Cost of mortality due to passive smoking (60 years and above) - Cost of morbidity 	<p>Used local data to estimate active and passive smoking-attributable mortality and morbidity in the productive years.</p> <p>- Prevalence-based disease specific cost of smoking approach</p>	<ul style="list-style-type: none"> - The annual value of direct medical costs, long term care and productivity loss was USD532 million for active smoking and USD156 million for passive smoking. - Passive smoking increases the costs of smoking by at least a quarter.
Nonnemaker and Sur (2007)	Setting: Bangladesh Study type: Prospective cohort	To examine the relationship between tobacco prices on child health outcomes and assess the potential for improved child health outcomes resulting from less household expenditure on tobacco.	<ul style="list-style-type: none"> - Tobacco expenditure based on village-level prices - District indicators - Demographic indicators - Village infrastructure - Land and farm equipment ownership 	<p>Three anthropometric indicators of child health and nutrition. Standardized measures of:</p> <ul style="list-style-type: none"> - Height for age (HAZ) for chronic malnutrition to define stunting. - Weight for height (WHZ) for short-term nutritional status to define wasting. - Weight for age (WAZ) for both short and long term nutritional status. 	<p>Estimated reduced form demand equations for children aged 2-10 years</p>	<ul style="list-style-type: none"> - Tobacco prices were found to be a significant determinant of height for age and weight for height for both boys and girls. - Price of tobacco products is a significant predictor of weight for age for girls and the pooled sample

Author(s), year	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method (s)	Findings/Conclusions
Arredondo A., Carrillo C. and Zuñiga A. (2007)	Setting: Mexico Study type: Case study	To determine the health care costs and economic burden of smoking-related diseases	- Chronic obstructive pulmonary disease (COPD) - Lung cancer - Asthma in smokers and non-smokers - Full treatment course with nicotine gum and patch	- Annual health care costs of 3 smoking-related diseases - Annual health care costs for full treatment course with nicotine patch and with nicotine gum.	Developed probabilistic models to predict expected changes in the epidemiological profile and the resultant changes in health care services needed for selected interventions	- Comparing results from 2006 and 2008 showed there was an expected 20-90% increase in the diseases reviewed and a resultant 25-93% increase in financial requirements. - Changes in demand for health services for patients with smoking-related respiratory illnesses will continue to increase.
Pu et al. (2008)	Setting: Taiwan Study type: Cross-sectional study	To estimate the crowding-out effects of tobacco and alcohol in a country with low expenditure shares on tobacco and alcohol	- Tobacco use, with adult-sex ratio as an instrument - Alcohol use, with adult ratio within household as an instrument	Share of expenditure categories in the total household budget.	- Used a Quadratic Almost Ideal Demand System for different expenditure categories. - Used the fractional logit method to estimate the marginal effect of tobacco and alcohol on other household expenditure spending.	- Lowest income households were most vulnerable to tobacco and alcohol use, despite an overall low expenditure. - Tobacco expenditure was significantly associated with lower expenditure in 18 of 31 categories at the lowest income group.

Author(s), year	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method (s)	Findings/Conclusions
Sturm et al. (2013)	Setting: South Africa Study type: Cross-sectional survey	To estimate the associations of tobacco use, excessive alcohol consumption and obesity with health expenditure and chronic diseases.	<ul style="list-style-type: none"> - Body mass index (in 3 categories) - Excessive alcohol intake (greater than 3 drinks a day) - Smoking (current and past regular smokers) 	Healthcare expenditure in three categories: <ul style="list-style-type: none"> - Outpatient expenditure only - Inpatient expenditure only - Total expenditure 	<ul style="list-style-type: none"> - Plotted a semi-parametric local polynomial estimate of expenditure on BMI - Multivariate analyses, ordinary least square regression model estimated the relationship of raw expenditures on the explanatory variables. 	Obesity and tobacco use were associated with increased health care expenditure, by as much as 11% for moderately obese individuals and 13 % for smokers.
Arrieta et al (2014)	Setting: Mexico Study type: Case control study design	To assess the direct medical costs attributable to smoking incurred by lung cancer patients	<ul style="list-style-type: none"> - Outpatient care - Operating room care (surgery) - Regular hospitalization - Intensive care unit hospitalization - Chemotherapy administration - Radiotherapy treatment - Palliative care 	Total cost of the disease <ul style="list-style-type: none"> - Average cost estimate per case - Case-specific cost estimate - Smoking attributable cost of disease 	<ul style="list-style-type: none"> - Used an incidence-based cost of illness approach - Micro-costing model was developed using the bottom up approach - Health care service provider perspective - Followed up for at least one year 	<ul style="list-style-type: none"> - Annual costs attributable to smoking are high for patients with recently diagnosed non-small cell lung cancer (NSCLC) over USD19.9 million in 2011. - Medical care costs were estimated at USD2.1 million in 2013.

Author(s), year	Details of study	Objective(s)	Explanatory variable(s)	Health outcome/ behaviours measured	Method (s)	Findings/Conclusions
Bundhamcharoen et al (2015)	Setting: Thailand Study type: Cross-sectional study	To assess the economic burden attributable to smoking in Thailand in 2009	Prevalence of seven diseases: - Lung cancer - COPD - Cardiovascular disease - Upper aeriodigestive tract cancer - Other cancer - Other respiratory diseases - Other medical conditions	- Direct medical costs - Indirect medical costs - Productivity loss due to premature deaths and absenteeism	- Used a prevalence-based disease-specific cost of illness approach	- Total economic burden of smoking was estimated at USD2.18 billion. - Productivity losses accounted for USD1.81 billion. - Total medical costs amounted to USD37 million. - The total cost of smoking accounted for 0.78% of the national gross domestic product and about 18.19% of total health expenditure.

Efroymson et al., (2001) represent one of the first studies, globally, to examine the impact of tobacco expenditures at the household level. An important aspect of this study was the calculation of the alternative essential purchases that could have been made if the money was not spent on tobacco. The study found that in Bangladesh a typical male smoker spent over five times, eighteen times and twenty times as much on cigarettes as for house rent, health and education, respectively. Tobacco expenditure was found to represent about 1.3 percent of the total household expenditure in rural areas, rising to 3.3 percent in urban areas, despite the poorest households being twice as likely to smoke as the wealthiest. The estimate is also likely to be an underestimation as the use of oral tobacco, a major part of tobacco use among females in India, was excluded from the analysis.

Building on the work of Efroymson et al. (2001), Nonnemaker and Sur (2007) conducted a prospective cohort study in which they examined the relationship between tobacco prices on child health outcomes as a result of reduced expenditure on tobacco. Their study focussed on the impact on child stunting, wasting and overall short-term and long-term nutritional status. Tobacco prices were found to be a significant determinant of stunting and wasting, irrespective of gender, and a significant predictor of nutritional status for girls, specifically and in the pooled sample. This study essentially gave credence to the notion present earlier by Efroymson and others (79) that tobacco expenditure led to a trade-off for expenditure on other commodities, even essential ones at the household level. However, Nonnemaker and Sur's study was still only able to suggest the potential benefit of reduced tobacco expenditure as a result of increased cigarette prices in a relatively short study that had limited generalizability. It used a small rural sample that may not have been representative of the larger urban Bangladeshi population.

Around the same period, Pu and others (80), used a more complex method to determine the crowding out effect of tobacco expenditure at household level in Taiwan. The authors

developed a quadratic almost ideal demand (QuAID) system – a series of demand equations for various expenditure categories and used a fractional logit (flogit) model to estimate the marginal effect of tobacco and alcohol consumption on other household expenditure. This method was further strengthened by the use of an instrumental variable method to account for endogeneity in the primary explanatory variables – tobacco and alcohol consumption. The findings showed that despite having relatively low expenditure in general, the lowest income households were most vulnerable to tobacco and alcohol consumption. Tobacco consumption, in particular was significantly linked to lower expenditure in eighteen of the thirty-one expenditure categories. Surprisingly however, expenditure on food was found to be positively associated to tobacco expenditure. This may be partially due to the limitation of extrapolating household level analysis to the individual level. For instance, an increase in household food expenditure may not necessarily be translated as an increase in the individual smoker's food expenditure.

In a prospective cohort study with a nested case-control design, Lwegaba (2004) estimated the tobacco-associated morbidity and hospital care costs in Barbados. The author found that medical complications were generally more frequent and severe with relatively poorer prognosis among smokers compared to non-smokers. In addition, smokers' hospital bills nearly doubled (1.86 times) that for non-smokers and were five times more than the government per capita health allocation. The study, however, only analysed health-related direct costs and did not take into account non-health-related direct costs nor indirect costs of smoking, thus likely underestimating the overall cost of smoking. Arredondo and colleagues (87) on the other hand, developed a probabilistic model to predict expected changes in the epidemiological profile of selected smoking-related diseases and the resultant changes in demand for healthcare services. The authors showed that there was an expected 20 to 90

percent increase in the disease prevalence with a corresponding 25 to 93 percent increase in related health expenditure.

Other studies have typically used the cost of illness approach to estimate the cost of smoking in various countries and at various levels (82–84,88). McGhee and colleagues (82) used a prevalence-based disease-specific approach to estimate the cost of smoking in Hong Kong, China. The study was especially comprehensive as it included the impact of both active and passive smoking – a feat rarely attempted in most cost of smoking studies. They estimated that the annual value of medical costs and productivity losses was approximately USD532 million for active smoking and USD156 million for passive smoking. This suggests that passive smoking increased the cost of smoking by at least a quarter of the cost of active smoking. Similarly, Anh et al. (33) and Bundhamcharoen et al. (83) both used the prevalence-based disease-specific approach to estimate the cost of smoking in Vietnam and Thailand, respectively. The total cost of smoking estimated in Vietnam was to be about USD1.17billion (0.97 percent of Vietnam’s Gross Domestic Product) while the Thailand estimate was USD2.18 billion with productivity losses accounting for over half the amount in both cases. These studies however are likely to have underestimated the full cost of smoking to their countries for two main reasons. Firstly, they both focussed on the cost of active smoking and unlike the earlier study by McGhee and others(82), did not include the costs related to passive smoking or exposure to second hand smoke. Secondly, the number of smoking related diseases assessed in the individual countries was not exhaustive. For instance, the study in Vietnam(33) used five smoking-related diseases while the study in Thailand (83) used seven. However, cigarette smoke harms nearly every part of the human body and has been linked as a causal factor for over ten diseases in men and women (12).

An alternative approach in the literature used to determine the cost of smoking is the incidence-based approach. Arrieta and others (84) used this approach in a case-control study

to estimate the direct medical costs attributable to smoking incurred by lung cancer patients in Mexico. They used a micro-costing method and developed a bottom-up approach to estimate the average cost per case as well as case-specific cost estimates. The authors found that the medical care costs were approximately USD2.1million in 2013 and the annual smoking-attributable costs for newly diagnosed lung cancer in particular were over USD19.9 million in 2011. The study results were however, not generalizable to the rest of the Mexican population as the sample used was not representative. Sturm and others (85) conducted a different study in South Africa to estimate the excess health care expenditures associated with tobacco use, excessive alcohol consumption and obesity. The authors found that tobacco use was associated with increased health care expenditure by as much as 13 percent, slightly higher than the increase associated with moderate obesity estimated at 11 percent. The results were however not generalizable to the rest of the country due to the pool from which the data was sampled – the country’s largest health insurance scheme. Owing to the high level of income inequality in the country, the number of black people that had access to this medical scheme was not representative of the country as a whole (85). This only sets to emphasise the need for careful consideration in choosing sources of data and even more careful interpretation of the results and their applicability.

The studies reviewed in this section of the paper can broadly be divided into two. Firstly, studies that sought to assess the impact of smoking on a range of outcomes either at household or individual level. These studies typically noted higher healthcare costs among smokers compared to non-smokers. This ranges from 13 percent higher costs to double the amount. In addition, a crowding-out effect was highlighted whereby tobacco expenditure at the household level led to lower expenditures in other categories of household expenditures. The second category of studies aimed to estimate the economic cost of smoking normally at the national level. Most of these studies estimated the overall economic cost of smoking to be

just below 1 percent of the respective countries' GDP. Importantly, these studies did not attempt to show any relationship between the socioeconomic disparities in smoking and disparities in healthcare costs. This study aims to fill that gap.

References

1. Ekpu, Brown A. The Economic Impact of Smoking and of Reducing Smoking Prevalence: Review of Evidence. *Tob Use Insights* [Internet]. 2015 Jul;1. Available from: <http://www.la-press.com/the-economic-impact-of-smoking-and-of-reducing-smoking-prevalence-revi-article-a4943>
2. World Health Organisation. The economic and health benefits of tobacco taxation. 2015.
3. Network of African Science Academies. Preventing a tobacco epidemic in Africa: A call for effective action to support health, social and economic development. Nairobi, Kenya; 2014.
4. African Union. The impact of tobacco use on health and socio-economic development in Africa. 2013.
5. Guindon GE, Guindon GE, Boisclair D, Boisclair D. Past, Current and Future Trends in Tobacco Use. *Population* (English Edition). 2003.
6. Hosseinpoor AR, Parker LA, Tursan d'Espaignet E, Chatterji S. Social determinants of smoking in low- and middle-income countries: Results from the world health survey. *PLoS One*. 2011;6(5).
7. Pampel F. Tobacco use in sub-Saharan Africa: Estimates from the demographic health surveys. *Soc Sci Med* [Internet]. 2008;66(8):1772–83. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0277953607006545>
8. Namibia Ministry of Health and Social Services. Demographic and Health Survey: Namibia. Windhoek; 2014.
9. World Health Organization (WHO). Non communicable Diseases Country Profiles

- [Internet]. Genève : WHO Press, 2014. 2014. Available from:
http://www.who.int/nmh/countries/ben_en.pdf?ua=1
10. Republic of Namibia Ministry of Health and Social Services. Namibia 2012/13 Health Accounts Report. Windhoek; 2015.
 11. Xu K, Saksena P, Jowett M, Indikadahena C, Kutzin J, Evans DB. Exploring the thresholds of health expenditure for protection against financial risk, Background Paper, No 19. 2010;22.
 12. U.S. Department of Health and Human Services. The health consequences of smoking—50 years of progress: A report of the Surgeon General [Internet]. Smoking and Health. Atlanta, GA; 2014. Available from: <http://ash.org/wp-content/uploads/2014/01/full-report.pdf%5Cnhttp://www.legacyforhealth.org/content/download/4428/62627/file/Abrams.SurGenReport.50thAnniv.2.5.14.FIN.pdf>
 13. U.S. Department of Health and Human Services. The Health Consequences of Involuntary Exposure to Tobacco Smoke A Report of the Surgeon General. Atlanta, GA; 2006.
 14. Sala-i-Martin X. 4 On the Health-Poverty Trap. Health and economic growth: Findings and policy implications. MIT Press; 2005. 95 p.
 15. Jauch H. Economic Perspectives on Global Sustainability Poverty , Unemployment and Inequality in Namibia Poverty , Unemployment and Inequality in Namibia. 2013;(2012).
 16. UNDP UNDP. Human Development Report 2015 Work for Human Development. 2015;288. Available from:

http://hdr.undp.org/sites/default/files/2015_human_development_report_1.pdf

17. Thompson ME. Estimating the Health Care Costs of Smokers. *Can J Public Heal.* 1983;74(3):183–90.
18. Leu RE, Schaub T. More on the impact of smoking on medical care expenditures. *Soc Sci Med. Pergamon;* 1985;21(7):825–7.
19. Leu RE, Schaub T. Does smoking increase medical care expenditure? *Soc Sci Med. Elsevier;* 1983;17(23):1907–14.
20. Rice DP, Hodgson TA, Sinsheimer P, Browner W, Kopstein N, Rice DP, et al. The Economic Costs of the Health Effects of Smoking , 1984. *Milbank Q.* 1986;64(4):489–547.
21. World Health Organization. Assessment of the Economic Costs of Smoking. *Economics of Tobacco Toolkit.* 2011.
22. Hodgson T. Cigarette smoking and lifetime medical expenditures. *Milbank Q* [Internet]. 1992;70(1):81–125. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/1588892>
23. Warner KE, Hodgson T a, Carroll CE. Medical costs of smoking in the United States: estimates, their validity, and their implications. *Tob Control.* 1999;8(3):290–300.
24. Kiiskinen U, Vartiainen E, Puska P, Pekurinen M. Smoking-related costs among in a 19-year individual follow-up. 2002;145–51.
25. Wacker M, Holle R, Heinrich J, Ladwig K-H, Peters A, Leidl R, et al. The association of smoking status with healthcare utilisation, productivity loss and resulting costs: results from the population-based KORA F4 study. *BMC Health Serv Res.* 2013;13:278.

26. Maciosek M V., Xu X, Butani AL, Pechacek TF. Smoking-attributable medical expenditures by age, sex, and smoking status estimated using a relative risk approach. *Prev Med (Baltim)* [Internet]. Elsevier Inc.; 2015;77:162–7. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0091743515001802>
27. Leartsakulpanitch J, Nganthavee W, Salole E. The economic burden of smoking-related disease in Thailand: A prevalence-based analysis. *J Med Assoc Thail.* 2007;90(9):1925–9.
28. Hayashida K, Imanaka Y, Murakami G, Takahashi Y, Nagai M, Kuriyama S, et al. Difference in lifetime medical expenditures between male smokers and non-smokers. *Health Policy (New York).* 2010;94(1):84–9.
29. Barendregt JJ, Bonneux L, van der Maas PJ. The health care costs of smoking. *N Engl J Med* [Internet]. 1997;337(15):1052–7. Available from: pm:9321534
30. Hiscock R, Bauld L, Amos A, Fidler JA, Munafò M. Socioeconomic status and smoking: A review. *Ann N Y Acad Sci.* 2012;1248(1):107–23.
31. Hill S, Amos A, Clifford D, Platt S. Impact of tobacco control interventions on socioeconomic inequalities in smoking: review of the evidence. *Tob Control* [Internet]. 2014;23(e2):e89-97. Available from: <http://tobaccocontrol.bmj.com/content/23/e2/e89.abstract>
32. Laaksonen M, Rahkonen O, Karvonen S, Lahelma E. Socioeconomic status and smoking: Analysing inequalities with multiple indicators. *Eur J Public Health.* 2005;15(3):262–9.
33. Hoang Anh PT, Thu LT, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. *Tob Control* [Internet]. 2014;25(1):96–100.

Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051821>

34. Yang L, Sung H-Y, Mao Z, Hu T, Rao K. Economic costs attributable to smoking in China: update and an 8-year comparison, 2000-2008. *Tob Control*. 2011;20(4):266–72.
35. Yao T, Huang J, Sung H-Y, Ong MK, Mao Z, Jiang Y, et al. Determinants of smoking-induced deprivation in China. *Tob Control* [Internet]. 2014;1–5. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051542>
36. Verguet S, Gauvreau CL, Mishra S, MacLennan M, Murphy SM, Brouwer ED, et al. The consequences of tobacco tax on household health and finances in rich and poor smokers in China: an extended cost-effectiveness analysis. *Lancet Glob Heal* [Internet]. 2015;3(4):e206–16. Available from: <http://www.thelancet.com/article/S2214109X15700951/fulltext>
37. Rutstein O.S. and Johnson K. DHS Comparative Reports No.6: The DHS Wealth Index. In 2004.
38. French, Michael T., Popovici I. That instrument is lousy! In search of agreement when using instrumental variables estimation in substance use research. *Health Econ* [Internet]. 2011 Jan;20(2):127–46. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21959306>
39. O’Donnell O, Doorslaer E Van. Analyzing Health Equity Using Household Survey Data,. Washington [Internet]. ... Health Equity Using 2008. 1-12 p. Available from: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Analyzing+Health+Equity+Using+Household+Survey+Data#5>

40. StataCorp. Stata Statistical Software: Release 13. Vol. 102, The Economic Journal. College Station, TX: StataCorp LP; 2013.
41. Kakwani A; van Doorslaer, E. NW. Socioeconomic Inequalities in Health: Measurement, Computation and Statistical Inference. *J Econom.* 1997;77(1):87–104.
42. Chen Z. CONCINDC: Stata module to calculate concentration index with both individual and grouped data. 2007.
43. World Health Organization. WHO global report on trends in prevalence of tobacco smoking 2015 [Internet]. WHO Magazine. 2015. Available from: http://apps.who.int/iris/bitstream/10665/156262/1/9789241564922_eng.pdf?ua=1
44. Eriksen M, Mackay J, Schluger N, Gomeshtapeh FI, Drope J. The Tobacco Atlas Fifth Edition. 2015.
45. Alavanja M, Baron JA, Brownson RC, Buffler PA, DeMarini DM, Djordjevic M V., et al. Tobacco smoke and involuntary smoking. *IARC Monogr Eval Carcinog Risks to Humans.* 2004;83:1–1413.
46. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease: An update. *J Am Coll Cardiol.* 2004;43(10):1731–7.
47. Powell JT. Vascular damage from smoking: disease mechanisms at the arterial wall. *Vasc Med.* 1998;3:21–8.
48. Doll R, Hill AB. Smoking and Carcinoma of the Lung. *BMJ* [Internet]. 1950 Sep 30;2(4682):739–48. Available from: <http://www.bmj.com/cgi/doi/10.1136/bmj.2.4682.739>
49. Doll R, Hill AB. Study of the Aetiology of Carcinoma of the Lung. *Br Med J* [Internet]. 1952;2(4797):1271–86. Available from:

<http://www.bmj.com/cgi/doi/10.1136/bmj.2.4797.1271>

50. Doll R, Hill AB. The Mortality of Doctors in Relation to Their Smoking Habits. *Br Med J*. 1954;1(4877):1451–5.
51. Royal College of Physicians of London. Smoking and health. Summary of a report of the Royal College of Physicians of London on smoking in relation to cancer of the lung and other diseases. Vol. 76, Pitman Medical Publishing. 1962. p. 234–6.
52. Stanhope B-J, Burdette WJ, Cochran WG, Farber E, Fieser LF, Furth J, et al. Report of the Advisory Committee to the Surgeon General of the Public Health Service [Internet]. ... , Education and Welfare, Public Health Service 1964. Available from: http://profiles.nlm.nih.gov/NN/B/B/M/Q/_/nnbbmq.ocr
53. U.S. Department of Health and Human Services. How Tobacco Smoke Causes Disease The Biology and Behavioral Basis for Smoking-Attributable Disease A Report of the Surgeon General How Tobacco Smoke Causes Disease : The Biology and Behavioral Basis for Smoking-Attributable Disease A Report of the Surgeon. 2010.
54. Strulovici-Barel Y, Omberg L, O’Mahony M, Gordon C, Hollmann C, Tilley AE, et al. Threshold of biologic responses of the small airway epithelium to low levels of tobacco smoke. *Am J Respir Crit Care Med*. 2010;182(12):1524–32.
55. World Health Organization. Protection from Exposure to Second-hand Tobacco Smoke. Policy Recommendations. 2007.
56. Hosseinpoor AR, Parker LA, Tursan d’Espaignet E, Chatterji S. Socioeconomic Inequality in Smoking in Low-Income and Middle-Income Countries: Results from the World Health Survey. *PLoS One*. 2012;7(8).
57. Hajizadeh M, Nandi A. The socioeconomic gradient of secondhand smoke exposure in

- children: evidence from 26 low-income and middle-income countries. *Tob Control* [Internet]. 2016 Jun 16;tobaccocontrol-2015-052828. Available from: <http://tobaccocontrol.bmj.com/lookup/doi/10.1136/tobaccocontrol-2015-052828>
58. Gartner CE, Hall WD. Is the socioeconomic gap in childhood exposure to secondhand smoke widening or narrowing? *Tob Control*. 2012;1–6.
 59. Miller VP, Ernst C, Collin F. Smoking-attributable medical care costs in the USA. *Soc Sci Med*. 1999;48(3):375–91.
 60. Miller LS, Zhang X, Rice DP, Max W. State estimates of total medical expenditures attributable to cigarette smoking, 1993. *Public Health Rep* [Internet]. 1998;113(5):447–58. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/18075245>
 61. Miller LS, Zhang X, Novotny T, Rice DP, Max W. State estimates of Medicaid expenditures attributable to cigarette smoking, fiscal year 1993. *Public Health Rep*. 1998;113(2):140–51.
 62. World Health Organization. WHO guide to identifying the economic consequences of disease and injury [Internet]. 2009. Available from: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:WHO+GUIDE+TO+IDENTIFYING+THE+ECONOMIC+CONSEQUENCES+OF+DISEASE+AND+INJURY#0>
 63. Rice DP. Estimating the cost of illness. *Am J Public Health Nations Health* [Internet]. 1967;57(3):424–40. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1227175&tool=pmcentrez&rendertype=abstract>
 64. Jo C. Cost-of-illness studies: concepts, scopes, and methods. *Clin Mol Hepatol*

- [Internet]. 2014;20(4):327–37. Available from:
[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4278062&tool=pmcentrez
&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4278062&tool=pmcentrez&rendertype=abstract)
65. Kang HY, Kim HJ, Park TK, Jee SH, Nam CM, Park HW. Economic burden of smoking in Korea. *Tob Control*. 2003;12(1):37–44.
 66. Max W, Rice DP, Sung H-Y, Zhang X, Miller L. The economic burden of smoking in California. *Tob Control* [Internet]. 2004;13(3):264–7. Available from:
[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1747911&tool=pmcentrez
&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1747911&tool=pmcentrez&rendertype=abstract)
 67. Wendy M. The financial impact of smoking on health-related costs: A review of the literature [Internet]. Vol. 15, *American Journal of Health Promotion*. 2001. p. 321–31. Available from: <http://www.scopus.com/inward/record.url?eid=2-s2.0-0343961984&partnerID=tZOtx3y1>
 68. Larg A, Moss JR. Cost-of-illness studies: A guide to critical evaluation. *Pharmacoeconomics*. 2011;29(8):653–71.
 69. Leistikow BN, Martin DC, Milano CE. Fire injuries, disasters, and costs from cigarettes and cigarette lights: a global overview. *Prev Med (Baltim)*. 2000;31(2 Pt 1):91–9.
 70. Chaloupka FJ, Warner KE. Chapter 29 The economics of smoking. In: *Handbook of Health Economics* [Internet]. 2000. p. 1539–627. Available from:
<http://linkinghub.elsevier.com/retrieve/pii/S1574006400800426>
 71. Pampel FC, Denney JT. Cross-National Sources of Health Inequality: Education and Tobacco Use in the World Health Survey. *Demography*. 2011;48(2):653–74.

72. Li DX, Guindon GE. Income, income inequality and youth smoking in low- and middle-income countries. *Addiction*. 2013;108(4):799–808.
73. Palipudi KM, Gupta PC, Sinha DN, Andes LJ, Asma S, McAfee T. Social determinants of health and Tobacco use in thirteen low and middle income countries: Evidence from Global Adult Tobacco Survey. *PLoS One*. 2012;7(3).
74. Agrawal S, Karan A, Selvaraj S, Bhan N, Subramanian S V., Millett C. Socio-economic patterning of tobacco use in Indian states. *Int J Tuberc Lung Dis*. 2013;17(8):1110–7.
75. Ayo-Yusuf OA, Olufajo O, Agaku IT. Exposure to secondhand smoke and voluntary adoption of smoke-free home and car rules among non-smoking South African adults. *BMC Public Health* [Internet]. 2014;14(1):580. Available from: <http://www.biomedcentral.com/1471-2458/14/580>
76. Beltrán-Sánchez H, Thomas D, Teruel G, Wheaton F, Crimmins EM. Links Between Socio-Economic Circumstances and Changes in Smoking Behavior in the Mexican Population: 2002–2010. *J Cross Cult Gerontol* [Internet]. 2013 Sep 26;28(3):339–58. Available from: <http://link.springer.com/10.1007/s10823-013-9203-8>
77. Boing a F, Antunes JLF, de Carvalho MB, de Góis Filho JF, Kowalski LP, Michaluart P, et al. How much do smoking and alcohol consumption explain socioeconomic inequalities in head and neck cancer risk? *J Epidemiol Community Health*. 2011;65(8):709–14.
78. Ayo-Yusuf OA, Olutola BG, Agaku IT. Cigarette Smoking Trends and Social Disparities Among South African Adults, 2003–2011. *Nicotine Tob Res*. Oxford University Press; 2015;17(8):1049–55.

79. Efroymsen D, Ahmed S, Townsend J, Alam SM, Dey a R, Saha R, et al. Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. *Tob Control*. 2001;10(3):212–7.
80. Pu C, Lan V, Chou Y, Lan C. The crowding-out effects of tobacco and alcohol where expenditure shares are low: Analyzing expenditure data for Taiwan. *Soc Sci Med* [Internet]. 2008 May;66(9):1979–89. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0277953608000221>
81. Nonnemaker J, Sur M. Tobacco expenditures and child health and nutritional outcomes in rural Bangladesh. *Soc Sci Med*. 2007;65(12):2517–26.
82. McGhee SM, Ho LM, Lapsley HM, Chau J, Cheung WL, Ho SY, et al. Cost of tobacco-related diseases, including passive smoking, in Hong Kong. *Tob Control* [Internet]. 2006 Apr;15(2):125–30. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/16565461>
83. Bundhamcharoen K, Aungkulanon S, Makka N, Shibuya K. Economic burden from smoking-related diseases in Thailand. *Tob Control*. 2015;1–6.
84. Arrieta O, Quintana-Carrillo RH, Ahumada-Curiel G, Corona-Cruz JF, Correa-Acevedo E, Zinser-Sierra J, et al. Medical care costs incurred by patients with smoking-related non-small cell lung cancer treated at the National Cancer Institute of Mexico. *Tob Induc Dis* [Internet]. 2014;12(1):25. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4316797&tool=pmcentrez&rendertype=abstract>
85. Sturm R, An R, Maroba J, Patel D. The effects of obesity, smoking, and excessive alcohol intake on healthcare expenditure in a comprehensive medical scheme. *South African Med J*. 2013;103(11):840–4.

86. Lwegaba A. Excess healthcare cost associated with a low smoking prevalence, Barbados. *West Indian Med J*. 2004;53(1):12–6.
87. Arredondo A, Carrillo C, Zuñiga A. Economic burden of expected epidemiological changes in diseases related to tobacco, Mexico. *Rev Saude Publica*. 2007;41(4):523–9.
88. Hoang Anh PT, Thu LT, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. *Tob Control* [Internet]. 2016;25(1):96–100. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051821>
89. World Health Organization. WHO report on the global tobacco epidemic: Raising taxes on tobacco. *World Heal Organ* [Internet]. 2015;52–3. Available from: www.who.int/tobacco
90. Vermeulen F. Do smokers behave differently? A tale of zero expenditures and separability concepts. *Econ Bull*. 2003;4(1).
91. Warner DO, Borah BJ, Moriarty J, Schroeder DR, Shi Y, Shah ND. Smoking status and health care costs in the perioperative period: a population-based study. *JAMA Surg* [Internet]. 2014;149(3):259–66. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4332384&tool=pmcentrez&rendertype=abstract>
92. Government of the Republic of Namibia. *Government Gazette of the Republic of Namibia*. 2014.
93. Government of the Republic of Namibia. *Government Gazette of the Republic of Namibia*. 2010 p. 1–26.
94. Benson FE, Kuipers MAG, Nierkens V, Bruggink J, Stronks K, Kunst AE.

- Socioeconomic inequalities in smoking in The Netherlands before and during the Global Financial Crisis : a repeated cross-sectional study. 2015;1–12.
95. Sturm R et al. The effects of obesity, smoking and excessive alcohol intake on health care expenditures in a comprehensive medical scheme. *South African Med J*. 2013;103(11):840–4.
 96. Neubauer S, Welte R, Beiche A, Koenig H-H, Buesch K, Leidl R. Mortality, morbidity and costs attributable to smoking in Germany: update and a 10-year comparison. *Tob Control*. 2006;15(6):464–71.
 97. Bolin K, Lindgren B. Smoking, healthcare cost, and loss of productivity in Sweden 2001. *Scand J Public Health [Internet]*. 2007;35(2):187–96. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17454923>
 98. Hassmiller KM, Warner KE, Mendez D, Levy DT, Romano E. Nondaily Smokers: Who Are They? *Am J Public Health*. 2003;93(8):1321–7.
 99. Lloyd-Richardson EE, Papandonatos G, Kazura A, Stanton C, Niaura R. Differentiating stages of smoking intensity among adolescents: Stage-specific psychological and social influences. *J Consult Clin Psychol [Internet]*. 2002;70(4):998–1009. Available from: <http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-006X.70.4.998>
 100. Lopez a. D, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. Vol. 3, *Tobacco control*. 1994. p. 242–7.
 101. Thun M, Peto R, Boreham J, Lopez AD. Stages of the cigarette epidemic on entering its second century. *Tob Control [Internet]*. 2012;21(2):96–101. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22345230>

C. Journal Article

Inequalities in smoking and healthcare costs: the case of Namibia

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Abstract

Background

The increased smoking prevalence in some parts of the world, particularly in Low and Middle Income Countries (LMICs) is a major concern among tobacco control advocates and governments. The higher smoking-related disease prevalence associated with this is expected to fall among the sub-populations least able to pay for healthcare services in LMICs. This, in turn, will perpetuate the vicious cycle of poverty and disease. The current study contributes to developing an understanding of the socioeconomic disparities in smoking in Namibia and their potential association with per capita health-related expenditures.

Method

Data from the Namibia 2013 Demographic and Health Survey, a nationally representative survey, are used in the study. Three main variables for healthcare costs are constructed, namely out-patient disease (OPD) costs, inpatient disease (IPD) costs and total out of pocket (OOP) payments. Concentration curves and indices are estimated for all three variables as well as for smoking intensity and smoking prevalence. Further, three Tobit regression models are run to examine the associations of the different healthcare costs with smoking intensity.

Results

The concentration index of smoking prevalence is estimated at -0.05 compared to -0.18 for smoking intensity. Thus, both smoking prevalence and smoking intensity, in relation to their socioeconomic status, are concentrated among the poor. In contrast, the concentration index of OPD healthcare costs is calculated at 0.34 compared to 0.65 for IPD healthcare costs reflecting disproportionately higher healthcare costs among the rich. The concentration index of the overall total annual OOP payments is 0.55. Tobit regression analysis, however, does not find any statistically significant relationship between the smoking intensity and the amount spent on health care costs, regardless of whether these were IPD, OPD healthcare costs or total OOP payments.

Conclusion

Namibia's current policies on demand reducing tobacco control policies can be strengthened by these findings. Smoking is an important determinant of several non-communicable diseases and has the potential to exacerbate health care costs across socioeconomic strata. Understanding the socioeconomic disparities in smoking is imperative for developing appropriate interventions against smoking.

Introduction

The World Health Organization estimates that tobacco use accounted for over 6 million premature deaths globally in 2015 (1). This includes some 600,000 premature deaths associated with second hand smoke (SHS) exposure. The global economic cost of morbidity and mortality attributable to tobacco use over the next 20 years is expected to be about US\$1.3 trillion or the equivalent of 1.3 percent of Gross Domestic Product (GDP) annually for all countries (1). With increased smoking prevalence in some parts of the world, the majority of these costs are expected to be borne by Low and Middle Income Countries (LMICs) placing further strain on their already overstressed health systems.

In Africa alone, smoking prevalence is estimated to increase from 15.8 percent in 2010 to 21.9 percent in 2030 – the largest anticipated increase by region (2). Disparities in tobacco use have been observed across ethnic or racial groupings, gender, socioeconomic status, education levels and geographical regions (3–5). The commensurate higher smoking-related disease prevalence is also expected to fall among the sub-populations least able to pay for healthcare services in LMICs thus contributing to the vicious cycle of poverty and disease (6)

Several studies have revealed that socioeconomic inequalities exist in the distribution of smoking in many countries (7,3). This has been shown using different measures of socioeconomic status (SES). For instance Laaksonen and colleagues found that education, occupational status and income were all inversely related to smoking (4). Hiscock et al. extended this and concluded that increased smoking prevalence will likely result in increased inequalities especially in terms of incidence of smoking-related diseases (7).

High income inequality remains a major issue in Namibia. Higher individual health-related expenditures, particularly those associated with cigarette smoking, have the potential to exacerbate this issue. Like many cost of smoking studies in recent years (8–13), studies

exploring the socioeconomic dimensions of cigarette smoking have focussed on developed countries, with only a few, mainly in Southeast Asia, dedicated to developing country settings. The current study will contribute to developing a better understanding of the socioeconomic inequalities in smoking in Namibia and their potential association with individual health-related expenditures.

Methods

Data

This study uses the 2013 Namibia Demographic Health Survey (DHS). The 2013 Namibia DHS is the fourth and most recent nationally representative DHS survey in the country. The survey uses a two-stage stratified cluster sampling method. Sampling probabilities are calculated separately for each sampling stage and for each cluster. In the first stage 554 enumeration areas (EAs) are selected with a stratified probability proportional to size from the sampling frame. The country's 13 regions are stratified into 26 sampling strata – 13 rural and 13 urban strata. A predetermined number of EAs are independently selected in every stratum from a complete list of households. The second stage involves the selection of 20 households in every urban and rural cluster according to equal probability systematic sampling. This study uses the individual dataset that focuses on data collected from men and women between the ages of 15-64 years. Socioeconomic variables are obtained from the household questionnaire.

Variables of interest

a. Health expenditure variables

Per capita healthcare expenditure variables are constructed based on out-patient disease (OPD) expenditure incurred in the last 4 weeks and in-patient disease (IPD) expenditure

incurred in the last 6 months, both of which are annualized. Thus the calculations of expenditures are done as follows:

- Annual OPD costs = Number of OPD visits in the last 4 weeks x Cost of the health care x
13
- Annual IPD costs = Number of overnight stays in the last 6 months x Cost for the stay x
2
- Total annual Out of pocket (OOP) payments = Annual OPD costs + Annual IPD costs

For easy comparison, all amounts are converted from Namibian Dollars (NAD) to United States dollars (USD) at the average exchange rate for 2013⁴.

b. Variables on smoking

Two variables are used for smoking, one is continuous and the other dichotomous. The number of cigarettes smoked in the previous 24 hours was used as the continuous smoking variable to estimate the smoking intensity. In contrast, the dichotomous smoking variable was generated by combining the different types of tobacco used, and coding all those with no reported smoking in the previous 24 hours to 0 and anyone with at least one cigarette smoked in the last 24 hours to 1. This represents the smoking prevalence.

c. Wealth index

The wealth index was constructed within the DHS dataset using a method developed by Rutstein and Johnson (14). The index makes use of household asset data, including ownership of consumer items such as source of drinking water, sanitation facilities and type of flooring material. This is done in three steps – First, a subset of indicators common to urban and rural areas is used to create wealth scores for households in both areas and transformed into binary indicators. Principal components analysis (PCA) method is then used

⁴ Average 2013 exchange rate: 1 NAD = 0.1040 USD

to produce a common factor score for each household. Second, separate factor scores are produced for households in urban and rural areas using area-specific indicators. The final step combines the separate area-specific factor scores to produce nationally applicable combined wealth index. After the index is computed, national-level wealth quintiles, ranked from lowest to highest are formed by assigning the household score to each household member. The ranking is divided into five equal categories (quintiles), each comprising 20 percent of the population.

Analytical methods

In this paper, the concentration index, a widely used measure of socioeconomic inequality, is calculated to examine the inequality in the distributions of smoking prevalence and smoking intensity, as well as on healthcare expenditures, specifically, OPD healthcare costs, IPD healthcare costs and total annual OOP payments. The concentration index is computed for microdata with a categorical welfare variable as follows:

$$C = \frac{2}{\mu} \sum_{t=1}^T f_t y_t R_t - 1$$

Where, μ is the mean level of the variable of interest, f_t is the group's population share, y_t is the group's average, and R_t is the relative rank calculated as:

$$R_t = \sum_{y=1}^{t-1} f_y - \frac{1}{2} f_t$$

and indicates the cumulative proportion of the population up to the midpoint of each group interval (15).

The concentration index ranges between 1 and -1 (16). Variables that are disproportionately concentrated among the rich have a positive concentration index while those disproportionately concentrated among the poor have a negative concentration index.

In terms of healthcare costs, OPD and IPD healthcare costs were first considered separately and then collated as total annual OOP payments. The analysis of inequality in the distribution of OPD costs and IPD costs is further enhanced and complemented by the use of concentration curves. The concentration curve displays the cumulative share of a variable of interest across cumulative proportions of individuals in the population ranked from poorest to richest. If the distribution of the variable of interest is distributed equally across the whole population, the curve will be a 45-degree line, known as the line of equality. However, if the variable takes on higher values among the poor, the curve will lie above the line of equality and vice versa.

To examine the relationship between smoking intensity, determined by the number of cigarettes smoked in the last 24 hours, and healthcare costs, we first identify households that incur healthcare costs. A large proportion in the dataset however, report zero expenditure on health care possibly due to abstention, lack of access to health services or because they could not afford the service at current prices and income levels (17).

A simple linear regression model would not be sufficient for such a scenario, instead a Tobit regression is used to model the relationship between smoking intensity and healthcare costs. The Tobit model is a truncated and censored variant of the nonlinear probit model. It allows observed data (i.e. the dependent variable) to be censored from above or below a fixed value. For example, allowing for the inclusion of only non-negative and non-zero observations for the dependent variable in the model.

The choice between a censored regression model and a truncated regression model is driven by assumptions about the source of zeros observed in the data. In the model estimated in this study, per capita health care expenditure is regressed on smoking intensity and other variables. The source of zeros in the per capita health care variable could arise from several sources. Firstly, it could be a result of a corner solution in which the household did not spend any money on healthcare during the period of interest. Second, it could be that the household was insured and did not have to spend its own money during the period. Despite relative high health insurance in Namibia, OOP payments still account for a large financial burden for the poorest households in the country (18). The second assumption above thus does not seem very realistic and we assume a zero expenditure is a result of a household not spending on health care during the period. This means a tobit truncation model works better, taking into account all positive expenditure on health care.

Three models are estimated, namely *Model 1* - the association with annual OPD health costs; *Model 2* – association with annual IPD health costs; and *Model 3* – association with total annual OOP payments. In all three models, the dependent variables (i.e. healthcare costs) were censored from below and therefore only included positive observations in the analysis. Several demographic and socioeconomic variables are also included in the models. Many of these were comparable to variables used in other similar studies (19,20). In addition, reasons for seeking care and the type of health facility visited are included to account for the influence of these factors on the dependent variables in the first two models. All analyses were conducted using Stata 13 (21).

Results

Table 1 compares the descriptive statistics for the overall population and the population of smokers. The table highlights that while most respondents in the overall population were female (about 52.5%), only 27.6% of smokers were female. Further, it depicts that most

smokers are urban based (57.2%). In terms of marital status, the overall population had more singles compared to married or cohabiting and divorced or widowed (34.6%, 21.9% and 4.9%, respectively) a trend comparable among smokers (single – 47.7%; married or cohabiting – 45.2%; divorced or widowed – 6.3%).

Table 1: Description of the study population

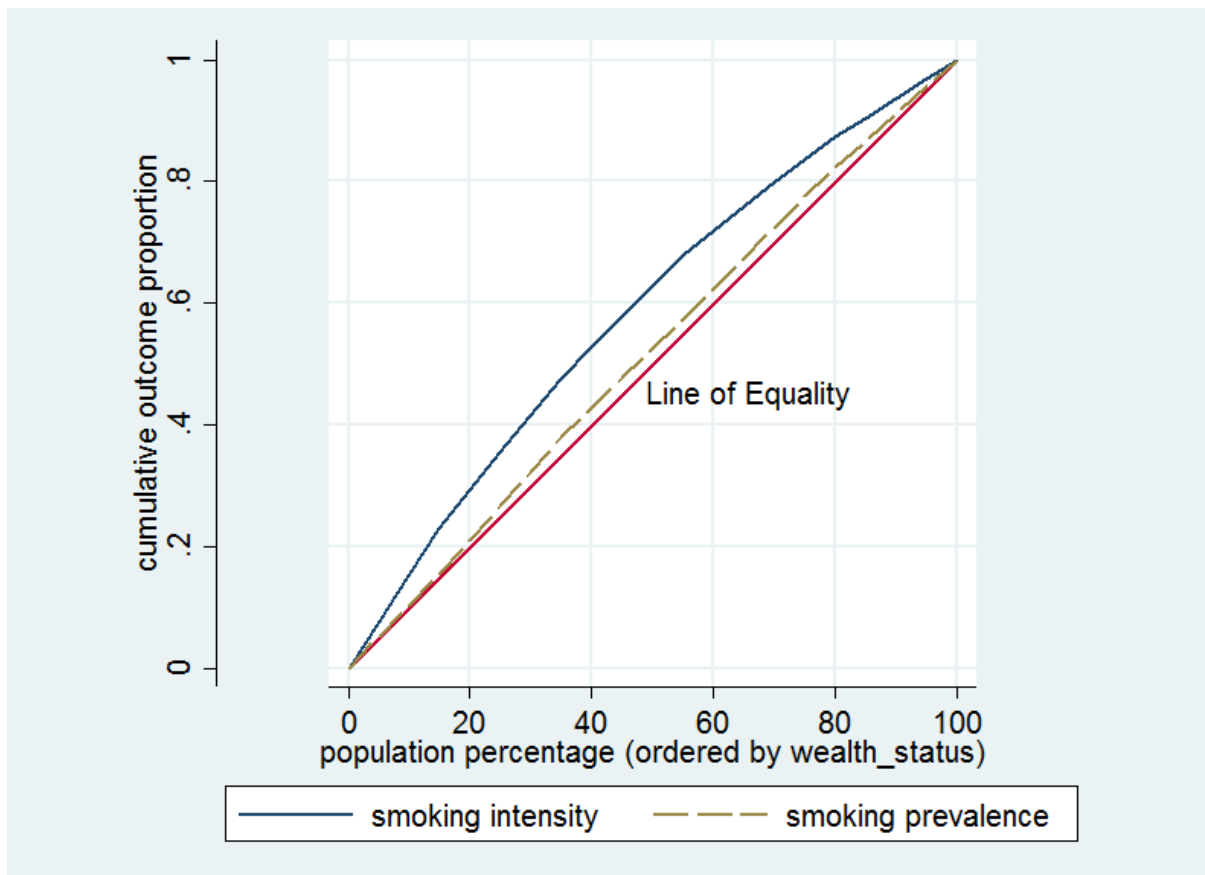
		Full population	Population of smokers
		Percent [95% CI]	Percent [95% CI]
	<i>Male</i>	47.6 [46.2 - 49.2]	72.4 [66.8 - 78.0]
	<i>Female</i>	52.5 [50.7 - 54.5]	27.6 [24.5 - 30.7]
Age category			
	<i>0-10 years</i>	28.5 [27.4 - 29.7]	--
	<i>11-20 years</i>	21.7 [20.7 - 22.7]	7.5 [5.7 - 9.3]
	<i>21-35 years</i>	23.5 [22.6 - 24.6]	43.7 [39.2 - 48.3]
	<i>36-50 years</i>	14.2 [13.7 - 14.9]	29.3 [26.0 - 32.7]
	<i>50+years</i>	12.0 [11.5 - 12.7]	19.5 [16.9 - 22.1]
Type of residence			
	<i>Rural</i>	53.2 [51.4 - 55.3]	42.8 [39.1 - 46.5]
	<i>Urban</i>	46.8 [44.5 - 49.3]	57.2 [51.7 - 62.8]
Marital status			
	<i>Single</i>	34.6 [33.3 - 36.0]	47.7 [43.1 - 52.5]
	<i>Married/Cohabiting</i>	21.9 [21.1 - 22.9]	45.2 [40.6 - 49.8]
	<i>Divorced/Widowed</i>	4.9 [4.6 - 5.2]	6.3 [4.8 - 7.6]
Education level			
	<i>No education</i>	26.8 [25.6 - 27.9]	15.8 [13.5 - 18.0]
	<i>Primary education</i>	33.2 [31.9 - 34.5]	28.3 [24.7 - 31.8]
	<i>Secondary education and above</i>	39.3 [37.8 - 40.9]	55.7 [50.3 - 50.3]
Wealth index			
	<i>Poorest</i>	--	17.3 [14.6 - 20.0]
	<i>Poor</i>	--	18.6 [15.6 - 21.7]
	<i>Middle</i>	--	17.5 [14.3 - 20.7]
	<i>Rich</i>	--	23.8 [19.2 - 28.6]
	<i>Richest</i>	--	22.7 [18.0 - 27.5]
Sample size, N		42,784	1,263

Note: 95% confidence intervals (CI) indicated in square brackets.

Education attainment was found to be fairly evenly distributed in the overall population, with 26.8% reporting no education, 33.2% reporting primary level of education and 39.3% reporting at least secondary level education. In comparison, few smokers (15.8%) reported no education, some (28.3%) reported at least a primary level of education while the majority (55.4%) had attained at least secondary education.

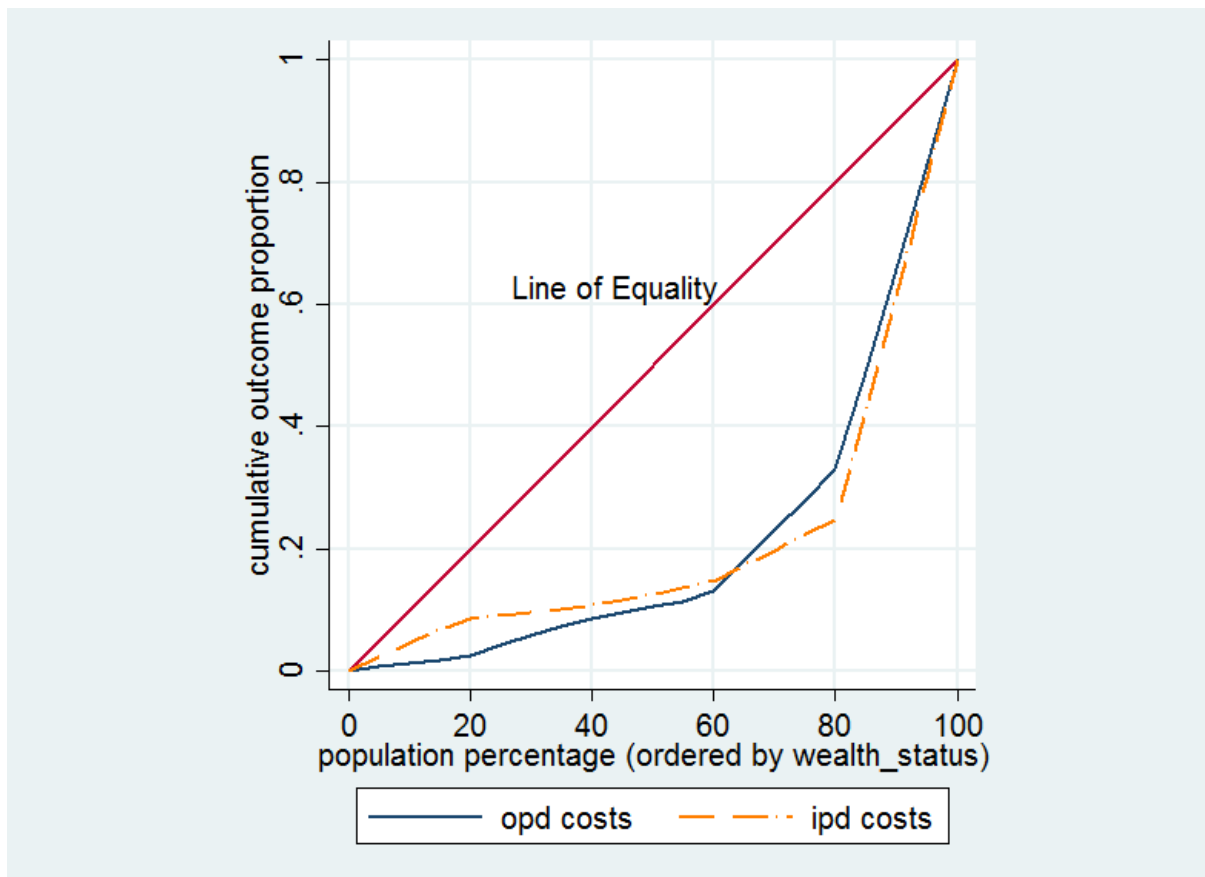
Figure 1 shows the concentration curves of smoking prevalence and smoking intensity. These curves both lie above the line of equality showing that smokers, in relation to their socioeconomic status, are concentrated among the poor. Smoking intensity is concentrated among the poor with a concentration index of -0.17 while the concentration index of smoking prevalence is estimated at -0.06.

Figure 1: Concentration curves for smoking prevalence and smoking intensity



The concentration index of OPD healthcare costs was calculated to be 0.32 compared to 0.60 for IPD healthcare costs. This reflects a greater concentration of IPD healthcare costs among the wealthy than among the poor. The concentration index of the overall total annual OOP payments was estimated at 0.50. Concentration curves for these costs are depicted in figure 2.

Figure 2: Concentration curves for OPD healthcare costs and IPD healthcare costs



Both concentration curves lie below the line of equality indicating a higher concentration among the rich compared to the poor. A separate graph, figure 3, shows the concentration curve for total OOP payments lying below the line of equality and therefore disproportionately higher among the rich.

Figure 3: Concentration curve of total annual OOP payments

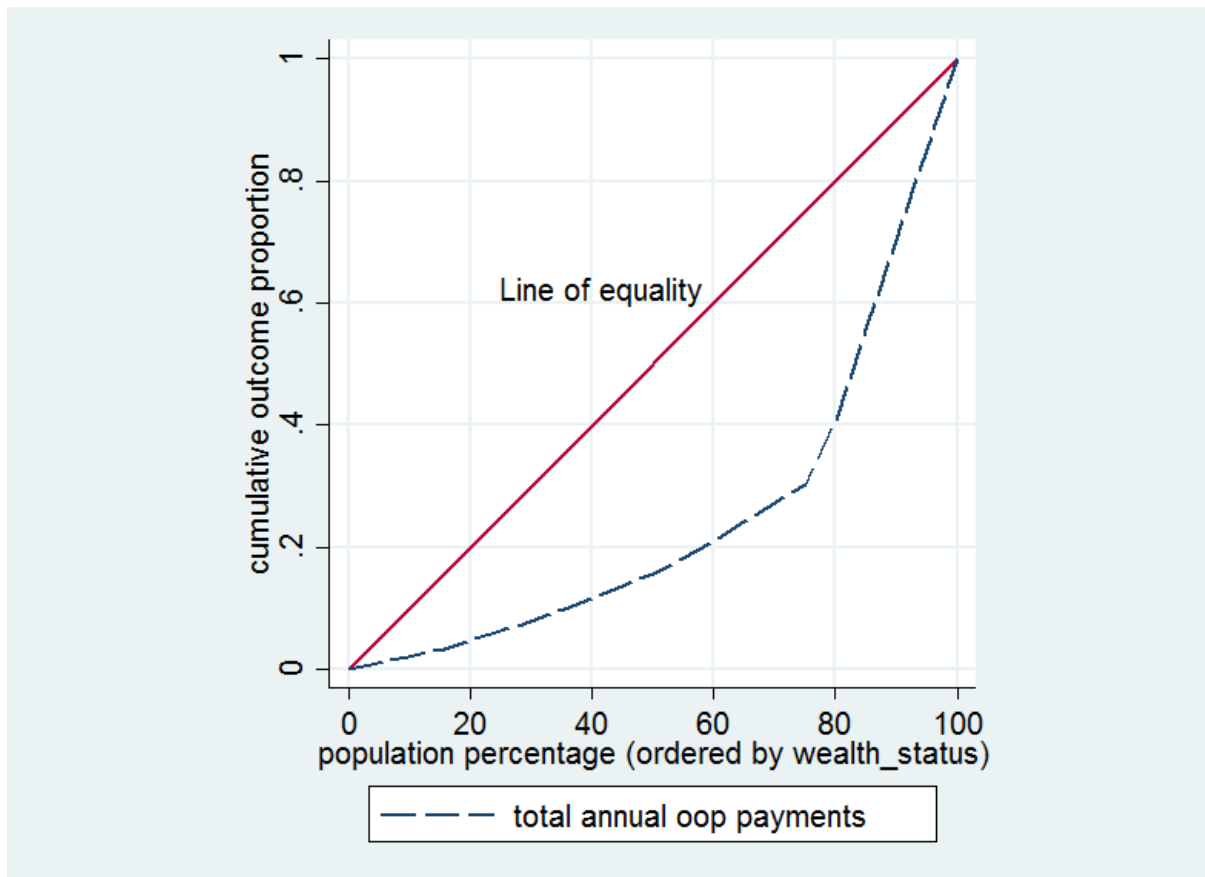


Table 3: Tobit regression model results

	Model 1: Annual OPD costs Co-efficient (p-value)	Model 2: Annual IPD costs Co-efficient (p-value)	Model 3: Total annual OOP payments Co-efficient (p-value)
Number of cigarettes smoked in the last 24hrs	-2.47 (0.25)	-4.42 (0.64)	-4.76 (0.32)
Age category (Base = 18-24 years)			
<i>25-34 years</i>	42.85 (0.57)	-325.02 (0.33)	-53.04 (0.74)
<i>35-44 years</i>	7.36 (0.95)	80.08 (0.83)	-421.97 (0.05)
<i>45-55 years</i>	112.89 (0.58)	1,268.43 (0.16)	-271.33 (0.29)
<i>Above 55 years</i>	-452.97 (0.04)*	1,236.73 (0.22)	-213.94 (0.44)
Gender (Base = female)			
<i>Male</i>	-1.28 (0.98)	-132.38 (0.56)	-532.24 (0.00)**
Geographic location (Base = Rural)			
<i>Urban</i>	336.24 (0.22)	954.37 (0.29)	-226.01 (0.42)
Marital status (Base = Single)			
<i>Married</i>	411.18 (0.01)**	632.55 (0.16)	839.51 (0.00)**
<i>Widowed or divorced</i>	-7.57 (0.97)	-1,289.05 (0.09)	-45.86 (0.88)
Education level (Base = No education)			
<i>Primary</i>	94.16 (0.44)	1,329.25 (0.04)*	685.07 (0.01)*
<i>At least sec</i>	412.90 (0.06)	2,087.39 (0.03)*	1,017.46 (0.01)**
Wealth index (Base = Poorest)			
<i>Poor</i>	203.22 (0.32)	542.48(0.37)	-47.91 (0.87)
<i>Middle</i>	266.94 (0.30)	161.74 (0.83)	445.41 (0.15)
<i>Rich</i>	168.85 (0.50)	201.09 (0.83)	523.61 (0.15)
<i>Richest</i>	-48.93 (0.91)	2,163.29 (0.05)	1,128.08 (0.02)*
Reason for care (Base = ANC/PNC/Pregnancy)			
Illness	599.39 (0.03)*	-1,916.18(0.14)	--
injury and other	-116.89 (0.63)	504.10 (0.78)	--
Type of facility visited (Base = Public facility)			
<i>Private facility</i>	1,669.40 (0.00)**	5,941.48 (0.01)*	--
<i>Other</i>	5,678.44 (0.06)	2,044.50 (0.04)*	--

All coefficients converted to USD

*p<0.05, statistically significant coefficients.

**p<0.01, statistically significant coefficients.

The results of the Tobit regression models are shown in Table 3. The regression results for all three models show no statistically significant relationship between smoking intensity and health care costs after controlling for other variables. For *model 1* the age category above 55 years, being married, illness as a reason for seeking care and using a private health facility were all found to be positively related to OPD healthcare costs and statistically significant. In comparison, *model 2* found statistically significant and positive associations between having primary schooling and at least secondary school level of education, on the one hand, and IPD healthcare costs on the other. In addition, compared to visiting a public health facility, visiting a private or other health facility were both found to be positively related to IPD healthcare costs and statistically significant. *Model 3* shows statistically significant relationships between total annual OOP payments and gender, being married, having primary schooling, having at least secondary school level of education and being in the wealthiest quintile.

Discussion

This paper shows that smoking inequalities exist in Namibia. The study finds that smoking prevalence and smoking intensity are both slightly more concentrated among the poor. This is consistent with the literature which notes smoking as disproportionately more prevalent among the poorest men than the richest across many low and middle income countries (5).

In contrast, the healthcare expenditure patterns observed in this study appear to reflect the overall income inequality in the country at large. The country remains one of the most unequal in the world with the Gini index of income inequality estimated at 0.61 (22). Thus, in general, those in the wealthiest quintile spent much more on health expenditure than those in the poorest, whether or not they smoked. Interestingly, however, when other factors have

been controlled for, Tobit regression analysis in this study did not find any statistically significant relationship between the number of cigarettes smoked in the last 24 hours and the amount spent on health care costs, whether IPD, OPD healthcare costs or total OOP payments.

On the other hand, several other factors, directly or indirectly linked to socioeconomic status, were found to be statistically significant. For instance, the type of health facility visited is statistically significant and reflects the higher costs related to use of private health facilities compared to public health facilities. In addition, those with higher education levels typically spend more on healthcare than those with less education.

Namibia's tobacco control policy is guided by the Tobacco Control Products Act of 2010. Under this legislation, several demand-reducing interventions were introduced and implemented from 2014 onwards (23,24). These include a complete ban on indoor smoking, bans on tobacco advertising, promotion and sponsorship, introduction of health warnings on tobacco products and taxes on tobacco products. It is clear that policy makers need to take into account socioeconomic differences in smoking status and intensity when developing tobacco control policies, especially in light of vast differences in income inequality in the country.

Policy interventions aimed at reducing smoking intensity and prevalence among the poor will invariably reduce the potential for smoking-related diseases among this vulnerable population. The Government may consider further raising existing cigarette taxes as an option to reduce the apparent inequality in smoking in the country. Evidence from other studies suggests that raising the price of tobacco products via taxation is the single most effective tobacco control intervention with the greatest potential to reduce socioeconomic inequalities in smoking (3). This stems from the fact that the poor tend to be more price

sensitive than the rich. The current prices for the most sold brand of cigarettes in the country comprises about 29% of excise tax compared to the WHO recommendation of at least 70% of retail price being excise tax (1). This suggests ample opportunity for further increases in the future.

The main strength of this study is that it adds to a growing body of literature on the impact of tobacco use in developing countries. Previous studies have generally focussed on either the socioeconomic inequalities associated with smoking (7,3,4,25), particularly in developed countries, or on the health costs of smokers in developed countries (19,26–29). Unlike other studies (30,9,31), however, the current study findings fail to establish a relationship between smoking and healthcare expenditures.

The study has a few limitations. Firstly, DHS data are not typically designed to answer tobacco-related research questions and thus the scope of available variables limited the types of analyses that could be done in relation to our research questions. The dataset, for instance, contained only one question on smoking that asked whether an individual within a household had smoked and the number of cigarette sticks consumed in the last 24 hours. This variable was used as a proxy for smoking intensity. However, smoking intensity is normally determined by looking at the amount of tobacco use over a period of at least one month. This allows for researchers to determine different ranges of smoking intensity and allows for differentiating daily smokers from weekly smokers and occasional smokers (32,33). This potentially left out some smokers that may not have smoked in the previous day. However, the number of such respondents in the dataset is unlikely to be large and significant enough to change the overall results found. Secondly, health expenses are not disaggregated by type of disease. Thus tobacco-related healthcare costs are lumped with non-tobacco-related healthcare costs, making it difficult to appropriately determine the impact of tobacco

consumption on smoking-related healthcare costs. This may have impacted on the non-significance of the relationship.

Future research is needed to determine the extent to which disparities in smoking intensity affect tobacco-related healthcare expenditures within the Namibian context. The impact of cigarette tax increases and other demand reducing interventions on reductions in smoking prevalence and smoking intensity inequalities are of particular interest and importance for the country.

Conclusion

Smoking is an important determinant of several non-communicable diseases and has the potential to exacerbate health care costs across socioeconomic strata. Understanding the socioeconomic disparities in smoking is imperative for developing appropriate interventions against smoking. This study shows that smoking prevalence and smoking intensity are disproportionately prevalent among the poor in Namibia. This suggests the potential for demand-reducing interventions to play a bigger role in the country.

Acknowledgements: The opinions expressed in this paper are those of the authors and do not in any way represent the position of the organisation(s) they represent.

Competing interests: None

Contributors: ZC wrote the first draft. JA and ZC were both involved in the analysis, interpretation of the results.

References

1. World Health Organization. WHO report on the global tobacco epidemic: Raising taxes on tobacco. *World Heal Organ* [Internet]. 2015;52–3. Available from: www.who.int/tobacco
2. Network of African Science Academies. Preventing a tobacco epidemic in Africa: A call for effective action to support health, social and economic development. Nairobi, Kenya; 2014.
3. Hill S, Amos A, Clifford D, Platt S. Impact of tobacco control interventions on socioeconomic inequalities in smoking: review of the evidence. *Tob Control* [Internet]. 2014;23(e2):e89-97. Available from: <http://tobaccocontrol.bmj.com/content/23/e2/e89.abstract>
4. Laaksonen M, Rahkonen O, Karvonen S, Lahelma E. Socioeconomic status and smoking: Analysing inequalities with multiple indicators. *Eur J Public Health*. 2005;15(3):262–9.
5. Hosseinpoor AR, Parker LA, Tursan d'Espaignet E, Chatterji S. Socioeconomic Inequality in Smoking in Low-Income and Middle-Income Countries: Results from the World Health Survey. *PLoS One*. 2012;7(8).
6. Sala-i-Martin X. 4 On the Health-Poverty Trap. *Health and economic growth: Findings and policy implications*. MIT Press; 2005. 95 p.
7. Hiscock R, Bauld L, Amos A, Fidler JA, Munafò M. Socioeconomic status and smoking: A review. *Ann N Y Acad Sci*. 2012;1248(1):107–23.
8. World Health Organization. Assessment of the Economic Costs of Smoking. *Economics of Tobacco Toolkit*. 2011.

9. Leartsakulpanitch J, Nganthavee W, Salole E. The economic burden of smoking-related disease in Thailand: A prevalence-based analysis. *J Med Assoc Thail.* 2007;90(9):1925–9.
10. Hoang Anh PT, Thu LT, Ross H, Quynh Anh N, Linh BN, Minh NT. Direct and indirect costs of smoking in Vietnam. *Tob Control* [Internet]. 2014;25(1):96–100. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051821>
11. Yang L, Sung H-Y, Mao Z, Hu T, Rao K. Economic costs attributable to smoking in China: update and an 8-year comparison, 2000-2008. *Tob Control.* 2011;20(4):266–72.
12. Yao T, Huang J, Sung H-Y, Ong MK, Mao Z, Jiang Y, et al. Determinants of smoking-induced deprivation in China. *Tob Control* [Internet]. 2014;1–5. Available from: <http://tobaccocontrol.bmj.com/cgi/doi/10.1136/tobaccocontrol-2014-051542>
13. Verguet S, Gauvreau CL, Mishra S, MacLennan M, Murphy SM, Brouwer ED, et al. The consequences of tobacco tax on household health and finances in rich and poor smokers in China: an extended cost-effectiveness analysis. *Lancet Glob Heal* [Internet]. 2015;3(4):e206–16. Available from: <http://www.thelancet.com/article/S2214109X15700951/fulltext>
14. Rutstein O.S. and Johnson K. DHS Comparative Reports No.6: The DHS Wealth Index. In 2004.
15. Kakwani A; van Doorslaer, E. NW. Socioeconomic Inequalities in Health: Measurement, Computation and Statistical Inference. *J Econom.* 1997;77(1):87–104.
16. O’Donnell O, Doorslaer E Van. Analyzing Health Equity Using Household Survey Data,. Washington [Internet]. ... Health Equity Using 2008. 1-12 p. Available

from:

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Analyzing+Health+Equity+Using+Household+Survey+Data#5>

17. Vermeulen F. Do smokers behave differently? A tale of zero expenditures and separability concepts. *Econ Bull.* 2003;4(1).
18. Gustafsson-Wright E, Asfaw A, van der Gaag J. Willingness to pay for health insurance: An analysis of the potential market for new low-cost health insurance products in Namibia. *Soc Sci Med.* Elsevier; 2009;69(9):1351–9.
19. Wacker M, Holle R, Heinrich J, Ladwig K-H, Peters A, Leidl R, et al. The association of smoking status with healthcare utilisation, productivity loss and resulting costs: results from the population-based KORA F4 study. *BMC Health Serv Res.* 2013;13:278.
20. Warner DO, Borah BJ, Moriarty J, Schroeder DR, Shi Y, Shah ND. Smoking status and health care costs in the perioperative period: a population-based study. *JAMA Surg* [Internet]. 2014;149(3):259–66. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4332384&tool=pmcentrez&rendertype=abstract>
21. StataCorp. *Stata Statistical Software: Release 13*. Vol. 102, The Economic Journal. College Station, TX: StataCorp LP; 2013.
22. UNDP UNDP. *Human Development Report 2015 Work for Human Development*. 2015;288. Available from: http://hdr.undp.org/sites/default/files/2015_human_development_report_1.pdf
23. Government of the Republic of Namibia. *Government Gazette of the Republic of*

- Nambia. 2014.
24. Government of the Republic of Namibia. Government Gazette of the Republic of Nambia. 2010 p. 1–26.
 25. Benson FE, Kuipers MAG, Nierkens V, Bruggink J, Stronks K, Kunst AE. Socioeconomic inequalities in smoking in The Netherlands before and during the Global Financial Crisis : a repeated cross-sectional study. 2015;1–12.
 26. Wendy M. The financial impact of smoking on health-related costs: A review of the literature [Internet]. Vol. 15, American Journal of Health Promotion. 2001. p. 321–31. Available from: <http://www.scopus.com/inward/record.url?eid=2-s2.0-0343961984&partnerID=tZOtx3y1>
 27. Sturm R et al. The effects of obesity, smoking and excessive alcohol intake on health care expenditures in a comprehensive medical scheme. South African Med J. 2013;103(11):840–4.
 28. Neubauer S, Welte R, Beiche A, Koenig H-H, Buesch K, Leidl R. Mortality, morbidity and costs attributable to smoking in Germany: update and a 10-year comparison. Tob Control. 2006;15(6):464–71.
 29. Bolin K, Lindgren B. Smoking, healthcare cost, and loss of productivity in Sweden 2001. Scand J Public Health [Internet]. 2007;35(2):187–96. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17454923>
 30. Maciosek M V., Xu X, Butani AL, Pechacek TF. Smoking-attributable medical expenditures by age, sex, and smoking status estimated using a relative risk approach. Prev Med (Baltim) [Internet]. Elsevier Inc.; 2015;77:162–7. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0091743515001802>

31. Efroymson D, Ahmed S, Townsend J, Alam SM, Dey a R, Saha R, et al. Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. *Tob Control*. 2001;10(3):212–7.
32. Hassmiller KM, Warner KE, Mendez D, Levy DT, Romano E. Nondaily Smokers: Who Are They? *Am J Public Health*. 2003;93(8):1321–7.
33. Lloyd-Richardson EE, Papandonatos G, Kazura A, Stanton C, Niaura R. Differentiating stages of smoking intensity among adolescents: Stage-specific psychological and social influences. *J Consult Clin Psychol* [Internet]. 2002;70(4):998–1009. Available from: <http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-006X.70.4.998>

D. Policy brief

Socioeconomic disparities in smoking in Namibia



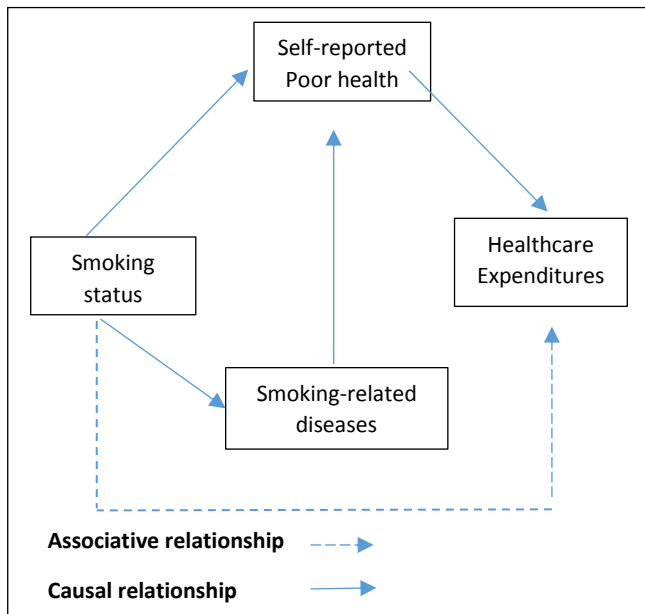
How does smoking affect healthcare expenditure?

Smoking and its impact on various illnesses has been investigated for over half a century. Researchers have linked active smoking to increased risk for various non-communicable diseases (NCDs) such as coronary heart disease (CHD), chronic obstructive lung disease, peripheral vascular disease, abdominal aortic aneurysm, stroke and infertility. Every year, about 5 to 6 million premature deaths can be attributed to smoking globally. This may increase to 8 million by 2030. The increased smoking-related illnesses and death ultimately lead to various economic costs, particularly for NCD-related treatments.

KEY POINTS

- Tobacco use in Namibia is higher among the poor, both in terms of prevalence and intensity of use.
- The Government needs to consider enhancing demand reducing interventions, in order to discourage initiation of tobacco use among the young and the poor.
- The Government needs to closely monitor changes in tobacco consumption as it addresses the challenge of income inequality in the country.

Figure 1: Linking smoking to healthcare expenditures



Source: World Health Organization (2011)

According to the World Health Organization (WHO), the economic costs associated with smoking-related illness and death is expected to be in the order of about US\$1.3 trillion over the next 20 years, mainly in low and middle income countries (LMICs). Figure 1 illustrates a conceptual framework developed by the WHO that links smoking status with health care

expenditures.

Who is most affected by this?

The literature shows that differences exist in smoking patterns and is concentrated mainly among the poor in most countries. Smoking therefore has the potential to contribute to the cycle of disease and poverty, where one reinforces the other and deepens the cycle. For instance, this is seen through reduced spending on education and food, coupled with increased spending on health care, especially among smokers in their later years.

In Namibia, smoking prevalence has been on the increase for just under two decades. This trend portends increases in smoking-related illnesses and premature death over-time in the country. Policy-makers thus need to take into account socioeconomic differences in smoking in order to accurately target and strengthen their tobacco control policies.

This study

The current study highlights the socioeconomic disparities in smoking prevalence and intensity in Namibia. To do this, data from the Namibia Demographic Health Survey (NDHS) 2013 is used. The NDHS is not primarily focussed on tobacco use, but contains some useful questions on smoking. The questions do not distinguish between long-term users and short-term users of tobacco products. Thus only the immediate past consumption patterns, i.e. within the last 24 hours, were used to distinguish those that smoke from those that do not smoke (smoking prevalence) as well as the number of cigarettes smoked, among those that did (smoking intensity).

The main findings of the study were that in Namibia, both smoking prevalence and smoking intensity were highest among the poor. Thus, like much of the literature, this study suggests a negative relationship between cigarette consumption and wealth status in Namibia. This is an important finding for the country's tobacco control policy. It suggests that smoking may already be contributing to the socioeconomic income inequality in the country.

Policy recommendations

It is clear that policy makers need to take into account socioeconomic differences in smoking status and intensity when developing tobacco control policies, especially in light of vast differences in income inequality in the country. Based on the results of this study, the government may need to consider demand-reducing policies aimed at reducing smoking intensity and prevalence among the poor. This will invariably reduce the potential for smoking-related diseases among this vulnerable population. For instance, raising cigarette taxes with an appropriate structure have been shown to be an effective tobacco control intervention with great potential to reduce socioeconomic inequalities in smoking. This stems from the fact that the poor tend to be more price sensitive than the rich. Current prices for the most sold brand of cigarettes in the country comprise about 29% of excise tax compared to

the WHO recommendation of at least 70% of retail price being excise tax. This suggests ample opportunity for further increases in the future.

In line with the above recommendation, it is probable that as the country's economy grows and income inequality is reduced, cigarettes may become affordable over time and increase the consumption across the wealth quintiles. This warrants some vigilance and a myriad of other tobacco control policies to curb the increase of smoking prevalence in the country.

Support and funding

The study was conducted by Zunda Chisha and funded by the Economics of Tobacco Control Project (ETCP) with funding from the Bill and Melinda Gates Foundation (BMGF).

Bibliography

Hill, S., Amos, A., Clifford, D. & Platt, S. 2014. Impact of tobacco control interventions on socioeconomic inequalities in smoking: review of the evidence. *Tobacco control*. 23(e2):e89-97. DOI: 10.1136/tobaccocontrol-2013-051110.

U.S. Department of Health and Human Services. 2014. *The health consequences of smoking—50 years of progress: A report of the Surgeon General*. Atlanta, GA. Available: <http://ash.org/wp-content/uploads/2014/01/full-report.pdf> <http://www.legacyforhealth.org/content/download/4428/62627/file/Abrams.SurGenReport.50thAnniv.2.5.14.FIN.pdf>.

World Health Organization. 2015a. *WHO global report on trends in prevalence of tobacco smoking 2015*. Available: http://apps.who.int/iris/bitstream/10665/156262/1/9789241564922_eng.pdf?ua=1.

World Health Organization. 2015b. WHO report on the global tobacco epidemic: Raising taxes on tobacco. *World Health Organization*. 52–53. Available: www.who.int/tobacco.

E. Appendices

Appendix 1: Plagiarism declaration

PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

2. I have used the Harvard convention for citation and referencing. Each contribution to, and quotation in, this essay/report from the work(s) of other people has been attributed, and has been cited and referenced.

3. This essay/report is my own work.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and declare that this is my own work.

Name Zunda Chisha

Signature _____

Date February, 2017

Appendix 2: Human Research Ethics Approval



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room E92-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6411
Email: nosl.bsama@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

16 May 2016

HREC REF: 296/2016

Dr J Ataguba
Room 1.08, Health Economics Building
Public Health & Family Medicine

Dear Dr Ataguba

PROJECT TITLE: THE IMPACT OF SMOKING ON INDIVIDUAL HEALTH EXPENDITURES: A CASE STUDY OF NAMIBIA (Mph-candidate-A Chisha)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30th May 2017.

Please comment on the fact that the budget for the study is R4000 but the sponsorship is R150, 000.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the student Zunda Chisha will also be involved in this study.

Please note that for all studies approved by the HREC, the principal Investigator **must** obtain appropriate institutional approval before the research may occur.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Yours sincerely

Signature removed

PP

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

HREC 296/2016

Appendix 3: Journal article guide for authors to Tobacco Control BMJ

Research papers

The word count excludes the title page, abstract, tables, acknowledgements and contributions and the references. Please include the word count of your manuscript on the title page. Please prepare your manuscript in 12 point Times New Roman font, double spaced.

Articles reporting research may be full length or brief reports. Papers should generally be a maximum of 3500 words in length, excluding tables, references, abstract and 'What this paper adds'. Exceptions may occasionally be made to this, particularly in the case of review articles, qualitative research and tobacco industry document research, but in general shorter papers will be more competitive for publication. The editors will consider the merits of the case for longer papers on a case-by-case basis, but papers longer than 5000 words will not be considered. Authors are strongly encouraged to observe the recommended length limitations, as excessive length may disadvantage an otherwise acceptable paper given the space limitations of the journal.

Authors should include a section entitled 'What this paper adds', which summarises the key messages from the research as follows:

- What is already known on this subject? In two or three single sentence bullet points please summarise the state of scientific knowledge on this subject. Be clear and specific, not vague.
- What important gaps in knowledge exist on this topic?
- What this study adds. In one or two single sentence bullet points give a simple answer to the question 'What do we now know as a result of this study that we did not know before?'. Be brief, succinct, specific, and accurate.

Word count: generally up to 3500 words.

Tables/Illustrations: up to 5

References: no limitation, but please use references only as needed

This article type is subject to internal and external peer review.

Pre-submission checklist

In order to reduce the chance of your manuscript being returned to you, please check:

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Appendix 4: ivtobit regression output

The IV initially proposed in this study was the variable *Frequency at which household members smoke inside the house*. However, following the ivtobit regression estimation, the subsequent Wald test for exogeneity of the instrumental variable yielded the results shown below:

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Tobit model with endogenous regressors      Number of obs   =      7954
                                           Wald chi2(19)   =      582.36
Log likelihood = -100305.87                 Prob > chi2     =      0.0000
```

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
annual_opd_costs						
smoking_intensity	-192.0668	351.2517	-0.55	0.585	-880.5074	496.3739
gender						
male	20.03845	805.4694	0.02	0.980	-1558.652	1598.729
age_cat_adult						
25-34 years	416.5706	1042.337	0.40	0.689	-1626.373	2459.514
35-44 years	-340.4552	1214.341	-0.28	0.779	-2720.519	2039.609
45-54 years	1134.19	1405.511	0.81	0.420	-1620.561	3888.941
above 55 years	-3167.87	1441.894	-2.20	0.028	-5993.931	-341.8087
geo_location						
urban	1359.673	909.7699	1.49	0.135	-423.4434	3142.789
maritalstat						
married	3248.409	889.5389	3.65	0.000	1504.945	4991.874
widowed or divorced	-161.6295	1526.566	-0.11	0.916	-3153.645	2830.386
educationlev1						
primary	762.6626	1259.599	0.61	0.545	-1706.105	3231.431
at least sec	3464.949	1479.818	2.34	0.019	564.5583	6365.34
wealth_status						
2	1388.167	1248.916	1.11	0.266	-1059.663	3835.998
3	2270.061	1238.888	1.83	0.067	-158.1141	4698.236
4	1343.294	1337.71	1.00	0.315	-1278.57	3965.158
5	467.989	1617.456	0.29	0.772	-2702.167	3638.145
reason_for_opd_care						
illness	4568.216	2133.242	2.14	0.032	387.1373	8749.294
injury and other	-851.9202	2272.543	-0.37	0.708	-5306.022	3602.182
type_of_hfvisited_opd						
private facility	14755.31	1013.246	14.56	0.000	12769.38	16741.23
other	52038.85	4730.997	11.00	0.000	42766.27	61311.43
_cons	-16020.92	2627.989	-6.10	0.000	-21171.69	-10870.16

smoking_intensity							
gender							
male	.8209166	.2532882	3.24	0.001	.3244809	1.317352	
age_cat_adult							
25-34 years	-.1589293	.3624515	-0.44	0.661	-.8693213	.5514626	
35-44 years	.5795151	.4145452	1.40	0.162	-.2329787	1.392009	
45-54 years	.5592117	.4827005	1.16	0.247	-.3868639	1.505287	
above 55 years	-.410832	.4871127	-0.84	0.399	-1.365555	.5438913	
geo_location							
urban	.1472801	.3140234	0.47	0.639	-.4681944	.7627547	
maritalstat							
married	.0526523	.3076037	0.17	0.864	-.5502399	.6555445	
widowed or divorced	-.0171714	.5118265	-0.03	0.973	-1.020333	.98599	
educationlevell							
primary	-.4427312	.4175181	-1.06	0.289	-1.261052	.3755894	
at least sec	-1.886361	.4336747	-4.35	0.000	-2.736348	-1.036374	
wealth_status							
2	-.0832819	.4201053	-0.20	0.843	-.906673	.7401093	
3	-.2382374	.4183368	-0.57	0.569	-1.058162	.5816876	
4	-.2338951	.4552491	-0.51	0.607	-1.126167	.6583768	
5	-.0911273	.5591002	-0.16	0.871	-1.186944	1.004689	
reason_for_opd_care							
illness	.6304477	.7206892	0.87	0.382	-.7820772	2.042973	
injury and other	.8646487	.7600332	1.14	0.255	-.6249889	2.354286	
type_of_hfvisited_opd							
private facility	-.1130614	.3604869	-0.31	0.754	-.8196028	.59348	
other	-1.121292	1.715093	-0.65	0.513	-4.482813	2.240229	
hv252	1.712291	.2060618	8.31	0.000	1.308417	2.116165	
_cons	1.156549	.8735915	1.32	0.186	-.5556593	2.868757	
/alpha	172.9732	352.613	0.49	0.624	-518.1355	864.0819	
/lns	10.30006	.0092584	1112.51	0.000	10.28191	10.3182	
/lnv	2.389634	.0079285	301.40	0.000	2.374095	2.405174	
s	29734.36	275.2926			29199.67	30278.85	
v	10.90951	.0864962			10.74129	11.08036	

Instrumented: smoking_intensity
Instruments: 1.gender 3.age_cat_adult 4.age_cat_adult 5.age_cat_adult
6.age_cat_adult 1.geo_location 1.maritalstat 2.maritalstat
1.educationlevell 2.educationlevell 2.wealth_status 3.wealth_status
4.wealth_status 5.wealth_status 2.reason_for_opd_care
3.reason_for_opd_care 2.type_of_hfvisited_opd 3.type_of_hfvisited_opd
hv252

Wald test of exogeneity (/alpha = 0): chi2(1) = 0.24 Prob > chi2 = 0.6237

Obs. summary: 2082 left-censored observations at annual_opd~s<=0
5872 uncensored observations
0 right-censored observations

For the Wald test of exogeneity, the null hypothesis is endogeneity while the alternative hypothesis is exogeneity. Thus, with the results indicated above, we reject the null hypothesis (it is not significant) and therefore there is no endogeneity and no need for an instrumental variable to be used. The final model used in this study did not use an instrumental variable.