



Brief report

Evidence on the Association Between Cigarette Smoking and Incident Depression From the South African National Income Dynamics Study 2008–2015: Mental Health Implications for a Resource-Limited Setting

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Abstract

Introduction: As a leading global disease risk factor, cigarette smoking has declined in some developed countries, but its health consequences are not well established in sub-Saharan Africa. This is particularly evident in South Africa, where few investigations have quantified the dually neglected challenges of cigarette smoking and depression, despite decades of research from developed countries. We investigated the association between cigarette smoking and incident depression, with the hypothesis that adolescents are particularly vulnerable.

Methods: Panel data from the South African National Income Dynamics Study, a nationally representative sample of households at follow-up periods (years 2008–2015), were used. Our incident cohort consists of 14 118 adult participants who were depression free at baseline. The generalized estimating equation models were fitted to assess the association between current cigarette smoking and incident depression.

Results: Current cigarette smoking among individuals aged at least 15 was significantly associated with incidents of depression among men (adjusted relative risk [aRR] = 1.16, 95% CI = 1.01 to 1.34), but not women. When the analyses were restricted to a sample population of older adolescents (ages 15–19), current cigarettes smoking was significantly associated with incident depression in both men (aRR = 1.84, 95% CI = 1.18 to 2.88) and women (aRR = 2.47, 95% CI = 1.15 to 5.29).

Conclusion: The results suggest an important relationship between cigarette smoking and incident depression, particularly among older adolescents, who are developmentally vulnerable and socioeconomically disadvantaged to experiencing depression. There is a considerable need to implement and prioritize culturally and developmentally appropriate prevention and cessation measures to reduce cigarette smoking and depression directed at adolescent populations.

Implications: There has been little population level research into the role of smoking on depression in sub-Saharan Africa, a region classified as a tobacco epidemic in the making. Our results have major implications for the often neglected crosscutting issues of tobacco control (Sustainable

Development Goal 3.9) and mental health (Sustainable Development Goal 3.4). They indicate the role of smoking on depression, with the association being particularly pronounced among adolescent who are developmentally vulnerable and socioeconomically disadvantaged, and emphasize the need to implement and prioritize prevention and cessation measures directed at this population.

Introduction

The high occurrence of smoking and mental illness constitutes two major, but often overlooked, public health challenges in South Africa. Tobacco use is arguably one of the leading preventable causes of poor health and premature mortality worldwide,^{1,2} but the shift of the tobacco epidemic to developing countries places the heaviest burden of related illness and death where health services are often not available. Chronic diseases are becoming a major public health challenge for an increasing number of South Africa's citizens, as are mental health problems. In particular, major depression, when untreated, is a debilitating mental disorder that affects large segments of the South Africa population (9.8% lifetime prevalence³). The treatment gap in mental health (~75%⁴) is also considerable in South Africa, and warrants the need to investigate the overlooked consequence of smoking on depression.

There is considerable evidence linking smoking and depression; based on numerous systematic reviews,⁵⁻⁷ including the benefits attributed to cigarette smoking cessation on depression, this being comparable to the treatment effect sizes of antidepressants.⁸ A number of hypotheses have been postulated to explain the relationship between smoking and depression. First, according to the self-medication hypothesis, individuals smoke to alleviate symptoms of depression, suggesting that depression precedes smoking, this being supported by longitudinal studies with adolescent and adult samples.^{5,9,10} A second hypothesis is that smoking leads to depression, which has been suggested in longitudinal studies among adolescents.¹¹ The specific mechanisms range from the effect of smoking on neurotransmission, which in turn increases the susceptibility to environmental stressors,¹² to psychological explanations that smoking leads to feeling out of control or sync with norms, and thus leads to depressive symptoms.¹¹ A third hypothesis suggests a bidirectional relationship between smoking and depression, with smoking initially being used to cope with depressive symptoms, with depression worsening over time.^{5,13} Finally, there may be no causal explanation between smoking and depression, but rather common genetic and environmental¹³ or confounding factors (eg mistaken withdrawal symptoms for mood symptoms).¹⁴ A recent systematic review reported inconsistent findings about which hypothesis is most strongly supported, and suggests the need for future studies to establish stronger causal inferences.⁵

Despite these findings, there appears to be limited research into the role of cigarette smoking on depression in sub-Saharan Africa, a region classified as a tobacco epidemic in the making,¹⁵ with little being known regarding its association among previously investigated subgroups,^{16,17} such as male/female, and adults/adolescents. In this study, we used nationally representative panel data to investigate the hypothesis that cigarette smoking increases the likelihood of subsequent (incident) depression among South Africa adults, with an added emphasis on identifying the detrimental role of smoking on depression among older adolescents.

Methods

Our study used the South African National Income Dynamics Study (SA-NIDS) data from wave 1 (2008), wave 2 (2010), wave 3 (2012), and wave 4 (2014/2015), this being a longitudinal panel survey of a nationally representative sample of households. As the first national panel study in South Africa, the SA-NIDS provides valuable insight into trends in various aspects of population living conditions and well-being in resource-limited settings. The study design and sampling methods are detailed in the technical report¹⁸ drafted by Southern Africa Labour and Development Research Unit/University of Cape Town, which implanted the SA-NIDS. Briefly, SA-NIDS employs a stratified, two-stage cluster sample design to obtain a nationally representative sample of households. In stage one, 400 of 3000 Primary Sampling Units (PSUs) from Statistics South Africa's Master Sample were selected for inclusion. The PSUs for the SA-NIDS are proportional to strata, based on the Master Sample district PSU allocation, with 400 being randomly selected within the NIDS strata. In stage two, two clusters of 12 dwelling units were selected from each PSU (for a total of 24 dwelling units per PSU). All consenting resident household members (≥ 15) at the selected dwelling units were administered the Adult questionnaires as part of the SA-NIDS study.

Data from the SA-NIDS Adult questionnaires were used for this current study, with older adolescents being classified as those aged 15-19 years, based on the World Health Organization's definition,¹⁹ and individuals aged 20 and above being labeled adults. To better isolate the potential effect of cigarette smoking, and lessen the possibility of reverse causation, our study constructed an incident cohort, consistent with previous studies.²⁰ This cohort consisted of those for whom at least two depression risk assessments were available within waves 1-4, with participants positive for significant depressive symptoms at their first observation being excluded. For the incident cohort, we right censored the data, either at the earliest observation at which a participant screened positive, or at the last observation, if the participant did not screen positive for depression. The University of KwaZulu-Natal Biomedical Research Ethics Committee approved the use of SA-NIDS data (BE 111/14).

Measures

Incident depression was the main study outcome, and smoking cigarettes the main study exposure, with two variables being required to establish an association. Depression statistics were obtained from the SA-NIDS Adult questionnaire, which included the 10-item abridged version of the Center for Epidemiologic Studies Depression Scale (CES-D), a commonly used psychometric valid/reliable instrument^{21,22} that captures self-reported depression-associated symptoms during the past week. Each of the 10 questions has four possible responses in a Likert format: 0 = rarely/none of the time (less than 1 day); 1 = some/little of the time (1-2 days); 2 = occasionally/moderate amount of time (3-4 days); and 3 = almost/all of the time (5-7 days). Depression symptomatology is based on a total score of the 10 questions from the CES-D (Cronbach's $\alpha = 0.73$). We dichotomized the CES-D measure using a total score of at least 10 as a

cutoff to signify significant depressive symptoms, consistent with a previous study.²³ The exposure to cigarette smoking was based on a response to a question in each of the SA-NIDS waves 1–4 Adult questionnaires “Do you smoke cigarettes?” to which the participants responded either “Yes” or “No.”

Statistical Analysis

First, we conducted a descriptive analysis of the participant’s sociodemographic and clinical details. Second, we investigated the association between smoking and incident depression by fitting generalized estimating equations with log links, which produces efficient and unbiased estimates for nonlinear data by accounting for the correlation of responses within people who are in panel data.²⁴ All regression analysis was stratified by sex (models 1–3), with three overarching models being fitted. The first model examined the association between adult cigarettes smoking and depression in all adults of age at least 15. This model was adjusted by race, age categories, marital status, education, employment status, household income, and residence. The second model examined the same associations, but among older adolescent (ages 15–19), whereas the third model only included adults (≥ 20). Given the nature of the complex survey design in the SA-NIDS, the analyses involving proportion and regressions were adjusted by poststratification weight.

Results

Baseline Sociodemographic Characteristics

Our incident cohort consisted of 14 118 participants, their baseline sociodemographic characteristics [Table 1] showing that 52.1% ($n = 7923$) were female, 50.8% were under 30 years old ($n = 7419$), of whom 27.1% ($n = 4207$) were aged 15–19, and 58.2% having never been married ($n = 8648$). Most were African ($n = 11 130$; 78.8%) and had completed high-school equivalent education ($n = 9735$; 64.4%).

Clinical Characteristics

The prevalence of significant depressive symptoms during follow-up periods of the incident cohort (ie study participants without depression at baseline) ranged from 20.7% (lowest; second follow-up period) to 22.8% (highest; third follow-up period). The prevalence of current cigarette smokers of the incident cohort ranged from 18.1% (lowest; baseline period) to 19.6% (highest second follow-up period).

Cigarettes Smoking and Incident Depression

The results of the adjusted regression [Table 2] showed that current cigarette smoking was significantly associated with incident

Table 1. Baseline sociodemographic characteristics of incident cohort ($N = 14 118$)

		Overall		Current cigarette smokers ^a	
		<i>n</i>	%	<i>n</i>	%
Gender	Male	6195	47.9	1775	29.4
	Female	7923	52.1	693	7.7
Race/ethnicity	African	11 130	78.8	1331	14.3
	Coloured ^b	2208	9.5	924	38.7
	Asian/Indian	190	2.5	38	17.7
	White	590	9.2	175	29.9
Age category:	15–19	4207	27.1	215	5.0
	20–24	1816	12.4	309	16.7
	25–29	1396	11.3	333	24.7
	30–34	1150	10.7	283	24.8
	35–64	4643	33.1	1184	25.7
Marital status	≥ 65	904	5.5	143	14.6
	Married	3421	28.6	750	22.4
	Living with partner	1025	6.6	314	26.3
	Widow/widower	731	4.3	102	12.5
	Divorced or separated	251	2.3	65	32.6
Education:	Never married	8648	58.2	1231	15.0
	Less than HS	1279	6.1	241	19.8
	Completed HS	9735	64.4	1751	18.2
Employment status	Beyond HS	3103	29.5	476	17.6
	Not employed	9267	61.2	1169	12.7
Household income	Employed	4740	38.8	1279	26.9
	Lowest 20%	2586	15.8	319	15.0
	Low/Middle 20%	3009	17.6	421	13.8
	Middle 20%	3086	19.0	579	17.7
	Middle/High 20%	3083	21.8	679	21.0
Residence	Highest 20%	2354	25.8	470	21.0
	Rural	7410	39.7	968	13.5
	Urban formal	5778	49.8	1339	22.2
	Urban informal	900	10.5	159	16.7

^a*n*/% for nonsmoker for each row category not displayed due to space limitation. % are adjusted based on poststratification weight to better match population estimates produced by Statistics South Africa. HS = high school.

^bThe “coloured” is term used by Statistics South Africa,³⁶ a South African ethnic label that includes children/descendants from black–white, black–Asian, black–colored, and white–Asian unions.³⁷

Table 2. Adjusted regression models on incident depression outcome

		Model 1a (Male; aged ≥15)			Model 1b (Female; aged ≥15)			Model 2a (Older adolescent male; ages 15–19)			Model 2b (Older adolescent female; ages 15–19)						
		aRR	SE	95% CI	aRR	SE	95% CI	aRR	SE	95% CI	aRR	SE	95% CI				
Race/ethnicity	[White]																
	African	1.89	0.45	1.18	3.00	1.81	0.33	1.27	2.57								
	Colored ^a	1.63	0.41	0.99	2.67	1.32	0.25	0.91	1.92								
	Asian/Indian	1.49	0.57	0.71	3.14	0.48	0.19	0.23	1.04								
Age category	[15–19]																
	20–24	1.86	0.22	1.47	2.35	1.81	0.20	1.46	2.25								
	25–29	2.28	0.30	1.76	2.97	2.07	0.23	1.67	2.57								
	30–34	1.90	0.29	1.42	2.55	2.59	0.30	2.06	3.25								
	35–64	2.52	0.32	1.96	3.25	2.45	0.25	2.01	2.99								
Marital status	≥65	3.28	0.58	2.31	4.64	2.69	0.35	2.09	3.46								
	[Married]																
	Living with partner	0.91	0.13	0.69	1.20	1.06	0.12	0.85	1.33								
	Widow/widower	1.43	0.28	0.97	2.11	1.39	0.13	1.15	1.68								
	Divorced/separated	1.17	0.31	0.69	1.97	1.15	0.19	0.84	1.58								
Education	Never married	1.31	0.13	1.08	1.60	1.31	0.09	1.14	1.51								
	[Less than HS]																
	Completed HS	1.01	0.10	0.83	1.22	0.95	0.07	0.81	1.11								
Employment status	Beyond HS	0.93	0.12	0.73	1.19	0.77	0.08	0.63	0.93								
	Not employed																
Household income	Employed	0.89	0.07	0.76	1.04	0.92	0.06	0.81	1.05	1.65	0.49	0.92	2.95	1.65	0.55	0.86	3.17
	[Lowest 20%]																
	Low/Middle 20%	0.87	0.09	0.72	1.06	0.90	0.07	0.78	1.05	1.30	0.29	0.84	2.01	1.36	0.34	0.83	2.21
	Middle 20%	0.70	0.07	0.57	0.85	0.90	0.07	0.78	1.05	0.87	0.23	0.51	1.48	0.90	0.24	0.54	1.51
	Middle/High 20%	0.65	0.07	0.53	0.81	0.91	0.07	0.78	1.07	1.41	0.37	0.84	2.36	1.47	0.40	0.86	2.51
Residence	Highest 20%	0.58	0.07	0.46	0.73	0.73	0.07	0.60	0.89	0.87	0.25	0.50	1.51	0.87	0.27	0.48	1.59
	[Rural]																
	Urban formal	1.21	0.08	1.06	1.38	1.30	0.07	1.17	1.44	0.88	0.18	0.60	1.31	1.03	0.19	0.71	1.48
	Urban informal	1.28	0.13	1.05	1.56	1.14	0.10	0.96	1.35	0.72	0.23	0.39	1.35	0.78	0.24	0.43	1.44
Currently cigarette use	[No]																
	Yes	1.16	0.08	1.01	1.34	1.17	0.15	0.91	1.51	1.84	0.42	1.18	2.88	2.47	0.96	1.15	5.29

^aThe “coloured” is term used by Statistics South Africa,³⁶ a South African ethnic label that includes children/descendants from black–white, black-Asian, black-colored, and white-Asian unions.³⁷ Bolded number means $P < .05$. The regression model adjusted based on poststratification weight (from final observation of the individual panel) to reflect more recent population estimates produced by Statistics South Africa. HS = high school; aRR = adjusted relative risk; SE = standard error; CI = confidence interval.

depression outcome among men aged at least 15 (model 1a: adjusted relative risk [aRR] = 1.16, 95% CI = 1.01 to 1.34), but not women (model 1b). Black Africans, older, widow/widower or never married, lower household quintile income, and residents from formal urban area had significantly increased risk of incident depression in both adult men (model 1a) and women (model 1b). When the analyses were restricted to the older adolescent subsample population, current cigarette smoking was significantly associated with incident depression outcome in both men (model 2a: aRR = 1.84, 95% CI = 1.18 to 2.88) and women (model 2b: aRR = 2.47, 95% CI = 1.15 to 5.29). A subsample analysis of the adult sample population yielded similar results to model 1, where the significant risk of incident depression due to current cigarette smoking was detected in men (aRR = 1.15, 95% CI = 1.01 to 1.33), but not women (results not shown in Table 2 due to space limitation).

Discussion

Current cigarette smoking among individuals aged at least 15 was significantly associated with incidents of depression among men, but not women. When the analyses were restricted to a sample of older adolescents (ages 15–19), current smoking of cigarettes was significantly associated with incident depression in both men and women. When untreated, depression is a debilitating disorder, with our findings highlighting the overlooked consequence of smoking on mental health outcomes in South Africa.

Our findings are consistent with the research that supports the hypothesis that cigarette smoking increases the likelihood of subsequent depression. In a recent systematic review of 51 studies investigating the association of smoking and later depression, the majority reported findings that support this hypothesis.¹⁴ Although the underlying mechanisms are unclear, the hypothesis is based on the premise that prolonged nicotine alters the neurochemicals in the regulatory systems, which may in turn make it difficult to regulate

stress or emotions.^{25,26} Other potential mechanisms that may explain the pathway between smoking and depression are environmental or psychosocial problems. Albers and Biener²⁷ found that rebelliousness (ie measured by several domains of problem behaviors) explained approximately 15% of the variation in the association between adolescent smoking and subsequent depression in young adulthood. Environmental factors, such as neighborhood social capital²⁸ and violence,²⁹ may also be important mechanisms to consider, given their significant association with depression and other poor health outcomes.^{30,31} Our study found subgroup differences in sex worth noting, with a notable link between cigarettes smoking and depression in adolescent males/female as well as adult males, but not in adult females. Further studies are needed to explore the potential mechanisms that help to explain the diminishing effect of cigarettes smoking on depression in adult women.

Our results have major implications for the often neglected crosscutting issues of tobacco use (Sustainable Development Goal 3.9³²) and mental health (Sustainable Development Goal 3.4³²) in sub-Saharan African countries. As supported by the *theory of fundamental causes*, which helps to explain the chronic persistence of socioeconomic disparity, despite advances in medical knowledge to prevent risks and treat certain conditions,³³ the consequence of smoking on depression remains heavily concentrated among the most socioeconomically disadvantaged (ie young) where poverty remains the highest in South Africa.³⁴ The key to reducing inequality, according to the theory,³⁵ is to reduce disparities in essential socioeconomic resources (eg knowledge, power, and social connections), which individuals from vulnerable groups lack, to enable them to protect and improve their health. Given the limited health services infrastructure in many developing countries, our findings highlight the need to implement cigarette smoking prevention and cessation approaches to reduce their use and treat depression, particularly prioritizing vulnerable groups, who often lack access to relating health education, or adequate support and resources to enable them to stop.

The conclusions drawn from this analysis should be interpreted with caution, first, as our depression outcome was based on self-reported depressive symptoms, with no information related to a formal diagnosis. Second, there was only one cigarette smoking measure available with a sufficiently high response rate to undertake this study. Third, we did not examine the role of other potentially causal factors of depression or nicotine/tobacco products aside from cigarettes, which limits our ability to isolate the unique effect of smoking. Notwithstanding these limitations, in summary, we found that cigarette smoking increases the likelihood of subsequent (incident) depression among South African adults, particularly older adolescents, who are developmentally and socioeconomically vulnerable to depression. Longitudinal research using birth cohorts or different methodologies (eg Mendelian randomization) would allow for making stronger causal inferences. Studies are needed to identify evidence-based and culturally and developmentally tailored cigarette smoking prevention/cessation measures for at-risk South African adolescents, which can be applied to vulnerable populations across sub-Saharan African countries.

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Declaration of Interests

None declared.

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