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Magnitude of substance use and determinants among married men in Ethiopia: Multilevel analysis using 2016 EDHS data

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4 1 **Magnitude of substance use and determinants among married men in**
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6 2 **Ethiopia: Multilevel analysis using 2016 EDHS data**
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Abstract

Objective: Substance use refers to the consumption of any substance that alters a person's mental, physical, and emotional functions. The use of licit and illicit substances has an impact on every level of society, including individuals and families. This study was designed to determine the magnitude and determinants of substance use among ever-married men in Ethiopia using 2016 EDHS data.

Design: Multilevel Analysis from Ethiopian demographic and health survey data.

Data source: Data was used from 2016 Ethiopian demographic and health survey data.

Participants: Ever married men from 2016 EDHS data.

Data extraction and Analysis: Data from the 2016 EDHS was used, specifically data from ever-married men. A total of 7793 ever-married men were involved in the analysis. A multi-level logistic regression model was used to identify the determinants associated with substance use, and statistical significance was declared at p-value < 0.05 and 95% CI.

Results: In this study, the substances (alcohol, cigarettes, and Khat) were currently used by 72.5% (95% CI 71.5, 73.4%) of the ever-married men. Individual and community-level determinants such as current age, secondary and higher education, employment, number of living children, HIV testing history, sexual incompatibility with their wife, frequent television watching, living in metropolises, and pastoralist regions were found to have a statistically significant association with substance use.

Conclusion: The overall magnitude of substance use among Ethiopian ever-married men was found to be substantial, in which alcohol was the most often used substance. Given these findings, it is critical to reduce the problem by improving modifiable individual-level variables such as educational status, and reducing substance advertising through the mass media.

Keywords; Ever-married men, Substance use, EDHS, Multilevel, Ethiopia

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56 49 **Strength and limitations of the study**

- 8 50 ➤ This was done in a nationally representative big sample.
- 10 51 ➤ Because the study is cross-sectional, it is impossible to draw any conclusions about a causal
11 52 relationship between the determinants and the outcome variables.
- 13 53 ➤ The frequency and dose of substances consumed, as well as clinical characteristics and the
14 54 effects of addiction to these substances, were not considered in the study.
- 16 55 ➤ The outcome variable was determined by asking questions rather than validating blood
17 56 samples, which may have influenced the extent of substance usage.
- 19 57 ➤ Because the response to substance use was based on respondents' self-reports, there could be a
20 58 rejection of use.
- 22 59 ➤ This study did not look at all of the substances; instead, it concentrated on the most frequent
23 60 ones (alcohol, cigarette, and Khat).
- 25 61
- 27 62

29 62 **Introduction**

30 63 Substance use refers to the consumption of any substance that alters a person's mental, physical, or
31 64 emotional functions, such as alcohol, tobacco, caffeine, illegal narcotics, and inhalants. For years, the
32 65 use of these substances has been an intrinsic component of human culture, with various
33 66 pharmacological effects. These substances can be used to ease tension and pain, to motivate the mind
34 67 to complete a task, or simply to have a good time with friends.¹⁻³

36 68 Around 48% of the world's adult population uses substances, including 2 billion alcoholics, 1.3
37 69 billion smokers, and 185 million others.^{4, 5} Alcohol and tobacco (cigarettes) are the most commonly
38 70 used substances across all age groups and constitute a significant contributor to the worldwide burden
39 71 of diseases.⁶⁻⁸ Most nations in Sub-Saharan Africa are currently undergoing significant economic,
40 72 social, and cultural transitions, which have produced a favorable environment for increased and
41 73 socially destructive substance use. As a result, an estimated 43 percent of adults in Africa have ever
42 74 consumed alcohol.^{9, 10}

43 75 The use of licit and illicit substances has an impact on every level of society, including individuals,
44 76 families, and overall government spending. Furthermore, these substances have disastrous health,

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77 socioeconomic, and environmental implications when used. Substance abuse is responsible for 5.4
78 percent of the worldwide burden of disease.^{11, 12} Tobacco and alcohol use have also been identified as
79 major risk factors for chronic diseases such as cancer, chronic pulmonary disease, diabetes, accidents,
80 violence, cancer, and liver cirrhosis. On the other hand, regular use of khat causes gingivitis, tooth
81 loss, gastrointestinal difficulties, cardiac complications, male impotence, insomnia, and a variety of
82 mental health issues. Alcohol is responsible for almost 4% to 6.2% of all male deaths globally. The
83 cost of substance abuse is estimated to be 28 million lost years of healthy living (disability-adjusted
84 life years) worldwide.^{10, 12-15}

85 Different small and large scale prior research in Ethiopia found that substance usage ranged from 23.86
86 to 62.5 percent.¹⁶⁻²⁰ Social mobility, accessibility, peer pressure, poor wealth, low level of education,
87 lower socioeconomic groupings, growing age, employment, and stressful life events, on the other
88 hand, were factors of substance use (khat, cigarettes, and alcohol). Furthermore, other motivations for
89 substance use have been found, including better well-being, euphoria, excitement, social
90 participation, increased alertness, stress reduction, increased capacity to focus, and addiction.¹⁷⁻²³

91 Substance abuse endangers people's health, as well as their social and economic well-being.^{24, 25} To
92 counteract these dangers; Ethiopia's government implemented a mandatory policy and raised taxes on
93 regularly used substances. Alcohol advertising is now forbidden in Ethiopia, according to
94 proclamation No. 759/2012, when the alcoholic content exceeds 12%.²⁶ despite the fact that we have
95 a proclamation to manage substance use, there is still significant difficulty with its execution, as well
96 as a lack of evidence about the extent of substance use and its determinants. There is no study on
97 substance usage among Ethiopian ever-married men that we are aware of. Thus, this study was
98 designed to determine the magnitude and determinants of substance use among ever-married men in
99 Ethiopia using 2016 EDHS data.

100 **Review questions**

- 101 ➤ What is the magnitude of substance use among ever married men in Ethiopia?
- 102 ➤ What are the significant determinants associated to substance use among ever married men in
103 Ethiopia?

104 **Methods**

105 **Patient and public involvement**

106 This study had no direct patient or public engagement.

107

Study setting and design

Ethiopia is Africa's second-most populated country, with 117.7 million people.²⁷ The country has a total size of around 1.0 million square kilometers and is bordered by the countries of Djibouti, Eritrea, Sudan, Kenya, and Somalia. Ethiopia is divided into three metropolitan (city) and nine non-metropolitan regions respectively [28]. According to the Ethiopia Demographic and Health Surveys (EDHS) report from 2016, roughly 61.4 percent of the men in the study have ever-married. From January 18 to June 27, 2016, a community-based cross-sectional survey was undertaken.²⁸

Data source and population

In this study, data from the 2016 EDHS were used, specifically data from ever-married men, with never-married men being omitted from the analysis.

Sample size and sampling methods

The entire demographic and health survey sample was designed to represent all of the country's regions and administrative cities. In the Ethiopian health and demographic survey (2016), two-phase sample procedures were used, with clusters being picked in the first phase and households being selected in the second.²⁹ Every region was divided into two sections: urban and rural. The sample size was then allocated using a probability proportional allocation method. The survey included around 645 clusters, with 200 from the urban and 443 from the rural. As a result, the study included a total of 7793 ever-married men, with 1,262 from the urban and 6,531 from the rural.

Data collection tool and quality assurance

The fundamental three data collection tools for the DHS were adopted from the demography and health survey project. These data collection tools include questions for the household, women, and men [28]. The data for this study came from the survey's men's questionnaire. The data questionnaire was first written in English and then translated into the three main local languages: Amharic, Afan Oromo, and Tigrigna. A pretest was conducted prior to data collection, and all data collectors, supervisors, and quality controllers who took part in the surveys received training.

Operational definition

Ever married man; a man who has been married at least once in their lives or on the date of data collection.

Substance use is defined as a self-report of exposure to at least one of the three substances (alcohol, khat, tobacco) prior to the interview irrespective of its dose and frequency (yes/no).³⁰

5

138 **Study variable and measurements**

139 **Outcome variable**

140 Substance use is the outcome variable with two outcomes (yes=1 when substance used and no=0, if
141 no substance used). Substance use was determined to depend on the ever-married men's self-report
142 using a single item for each substance. 'Do you currently smoke or use any other type of tobacco
143 every day, some days, or not at all?' As a result, anyone who reported every day or some days was
144 taken as a current smoker. Khat chewing and alcohol use behaviors were also determined using:
145 'During the last 30 days, how many days did you chew khat?' and 'During the last 30 days, how
146 many days did you have a drink that contains alcohol?' In both issues, anybody who described at
147 least one day of use in the former 30 days was taken as current khat or alcohol user'.²⁸ The magnitude
148 of substance use was calculated by dividing the number of substance uses (obtained from a composite
149 score of three substances) by the total number of ever-married men from the 2016 EDHS datasets.

150 **Independent variables**

151 The individual and community-level independent variables were included. **Individual-level**
152 **variables** involve men's current age (15-24, 25-34, 35-44, >=45 years), educational status (no formal
153 education, primary, secondary, and above), religion (Christian, Muslim, and others), employed (yes,
154 no), number of living children (0, 1-2, 3-5, >=6), wealth index (poor, middle and rich), land
155 ownership (yes, no), housing ownership (yes, no), wife refusing sexual intercourse/sexual
156 incompatibility (yes, no), had any STI (yes, no), ever tested for HIV (yes, no), Frequently watching
157 television(not at all, at least once a week), have a bank account(yes, no). **Community-level variables**
158 include place of residence (urban, rural) and regions recoded into agrarian, pastoralist, and
159 metropolises (city). The agrarian region is obtained by recoding Tigray, Amhara, Oromiya, and South
160 Nation Nationality People republic (SNNPR) regions; pastoralist region involves Afar, Somali,
161 Benishangul, and Gambella regions. The metropolises (city) administration regions include Harari,
162 Addis Ababa, and Dire Da'wa. Residents living stability and social change index were used to
163 combine these regions. The regions considered as a city (metropolis) have a greater social change
164 index in relation to other regions; in addition, the pastoral regions are originated in the lowland areas
165 of Ethiopia, mostly travel from place to place with their cattle to find grass and water. The agrarian
166 regions are originated in the highland area of the country, in which agriculture is a principal work of
167 these people.

168 **Data extraction and analysis**

169 STATA software version 14 was used to analyze the data. The weighted samples were employed in
170 data analysis to ensure that the survey results were representative of national and regional findings.
171 To ensure the survey's representativeness by regions and account for non-response, data were
172 weighted using the men's data weighting variable (mv005/106) as recommended by the DHS. Using
173 STATA's'svy' function, the analysis was also employed to describe the complex survey design and
174 resilient standard errors (stratification and clustering). Tables and graphs were used to generate and
175 organize descriptive statistics such as frequency and percentages. Individual and community-level
176 variable frequencies were calculated in relation to the outcome variable. The factors of substance use
177 were identified using a multi-level logistic regression model. At the same time, four models were
178 fitted to estimate the fixed influence of both individual and community level determinants as well as
179 the random effect of cluster fluctuations. The null model, which was run without any determinants,
180 was the first. The effect of individual-level determinants on substance use was estimated using the
181 second model. The third model was used to calculate the impact of community-level factors on
182 substance use. Finally, the fourth model prediction is made. The Proportional Change in Variance
183 (PCV) was also computed to estimate the power of variables included in each model in predicting
184 substance use. The Intra-Cluster Correlation (ICC) was determined to indicate random effects within
185 a model.^{31, 32} Akaike's Information Criterion (AIC) and Bayesian information criteria (BIC) were used
186 for model selection. Each value of AIC and BIC in all models with the lowest value was selected.^{33, 34}
187 The median odds ratio (MOR) was calculated to indicate mysterious cluster heterogeneity.³¹
188 Variables having *P*-value up to 0.2 in the multilevel bivariate logistic regression analysis were
189 considered to fit multilevel multivariable logistic regression analysis. Variance inflation factor was
190 used to notice multicollinearity within individual-level determinants. The fixed effects of individual
191 and community level determinants on substance use were stated using an adjusted odds ratio (AOR)
192 with 95% confidence intervals (CI). Accordingly, the final (4th model) was used to designate the
193 combined effect of individual and community-level determinants on substance use among ever-
194 married men. A *P*-value < 0.05 and an adjusted odds ratio with 95% confidence intervals were
195 considered to declare statistical significance.

196 **Results**

197 **Socio-demographic characteristics of ever-married men**

198 The analysis included a total of 7793 ever-married men from the 2016 demographic and health
 199 survey. The men's mean age (standard deviation) was 37.3 (9.7), and 42% of ever-married men had
 200 never attended formal education. The Oromiya region had about 38% of ever-married men, and 83.8
 201 percent of them lived in rural areas. The majority of men who had ever-married had three to five
 202 living children and 96.1 % of ever-married men were actively employed. (Table 1)

203 **Table 1: Socio-demographic characteristics of ever-married men in Ethiopia using 2016 DHS**
 204 **(n= 7,793)**

Variables	Weighted frequency	Percent
Age of the respondents		
15-24	566	7.3
25-34	2745	35
35-44	2484	32
>=45	1998	25
Educational status		
No formal education	3284	42
Primary education	3179	40
Secondary and above education	1329	17
Religion		
Christian	5076	65
Muslim	2610	34
Others	106	1
Employed		
Yes	7492	96.1
No	300	3.9
Number of living children		
No children	827	10.6
One to two children	2247	28.8
Three to five children	2771	35.6
Six and above	1948	25.0
Wealth index		
Poorest	1366	17.5
Poorer	1617	20.8
Middle	1550	19.9
Richer	1584	20.3
Richest	1674	21.5
Place of residence		
Urban	1262	16.2
Rural	6530	83.8
Region		
Harari	19	0.25

Gambella	21	0.3
Dire Dawa	41	0.5
Afar	59	0.8
Benishangul Gumuz	84	1.1
Somali	208	2.7
Addis Ababa	278	3.6
Tigray	461	5.9
SNNPR	1570	20.1
Ahmara	2090	26.8
Oromiya	2961	38.0

The magnitude of substance use among ever-married men

The substances (alcohol, cigarette, and Khat) were currently used by 72.5% (95% CI 71.5, 73.4%) of the ever-married men in this study, while 27.6 % (95 % CI 26.6, 28.6%) of the men had not used them. Approximately 59.6%, 11.8 percent, and 1.1 percent of ever-married men, respectively, used one, two, or three substances. A larger percentage (23.3 and 25.6 percent) of ever-married men was reported to use the substance in the age groups of 25-34 and 35-44 years old, respectively. The majority of those who have used substances had no formal education (33 percent). Employed men, on the other hand, accounted for 70% of all substance users. Khat and alcohol were the two most commonly utilized substances by ever-married men. Furthermore, ever-married men residing in rural areas and agrarian regions reported 60.3 and 65.7 percent of substance use, respectively. (Table 2) (Fig 1, Fig 2)

Determinants of substance use

We have conducted a multilevel logistic regression analysis using the 2016 EDHS data to identify the individual and community-level determinants associated with substance use. The interclass-correlation in the empty model showed 52.2% variability in the magnitude of substance among ever-married men recognized to the difference between clusters in the community. Additionally, the variability among clusters in Model II was 50.1%, 48.1% in Model III, and 47.2% in Model IV. The proportion of change in the variance was 41.8% for Model II (individual-level determinants), 45.4% for Model III (community-level determinants), and 56.8% for Model IV (combined individual-and community-level determinants) in which addition of the determinants to empty model well explained within three models, particularly in the final model.

227 **Individual-level determinants:** The odds of substance use were 61 and 81% higher among ever-
 228 married men who were with the age category of 25-34 (AOR = 1.61; 95% CI: 1.22, 2.12) and 35-44
 229 (AOR = 1.81; 95% CI: 1.33, 2.47) in relation to men within the age category of 15 to 24 years old.
 230 The ever-married men who had attended secondary and above education were 37% less likely to use
 231 substances compared to men who had no formal education (AOR = 0.63; 95%CI: 0.49, 0.80). The
 232 odds of substance use were 24% higher among ever-married men who had three to five living
 233 children in relation to their counterparts (AOR = 1.24; 95% CI: 1.03, 1.50). The odds of substance
 234 use among employed ever-married men were 34% higher in relation to unemployed men (AOR =
 235 1.34; 95%CI: 1.04, 1.74). The odds of substance use were 66% higher among ever-married men who
 236 had a sexual incompatibility with their wives compared to their counterparts (AOR = 1.66; 95%CI
 237 1.10, 2.52). On the other hand, among ever-married men who had ever tested for HIV were obtained
 238 to have 38% higher odds of substance use than in relation to their counterparts (AOR = 1.38; 95%CI
 239 1.18, 1.63). Similarly, the ever-married men who were watching television at least once a week had
 240 49% higher odds of substance use compared to their counterparts (AOR = 1.49; 95%CI 1.24, 1.79).

241 **Community-level determinants:** The odds of substance use among ever-married men who were
 242 living in the metropolises (city) regions were 2.3 times more likely than those who were living in the
 243 agrarian regions (AOR = 2.30; 95%CI: 1.38, 3.82). Besides, there were 64% lower odds of substance
 244 use among ever-married men living in the pastoralist region compared to those living in the agrarian
 245 regions (AOR = 0.36; 95%CI: 0.25, 0.52). (Table 3)

246 **Table 2: Multilevel bivariable logistic regression analysis of substance use among ever- married**
 247 **by individual and community level determinants from 2016 EDHS data (n = 7793)**

Variables	Substance use		COR 95% CI	P-value
	Yes n (%)	No n (%)		
Age of the respondents				
15-24	383(4.9)	183(2.4)	1	
25-34	1998(25.6)	748(9.6)	1.62(1.25, 2.10)	< 0.001
35-44	1818(23.3)	666(8.6)	1.81(1.39, 2.35)	< 0.001
>=45	1447(18.6)	551(7.1)	1.61(1.23, 2.12)	0.001
Educational status				
No formal education	2571(33)	713(9.2)	1	
Primary education	2186(28.1)	994(12.8)	1.13(0.96, 1.33)	0.157
Secondary and above education	889(11.4)	440(11.4)	0.89(0.73, 1.10)	0.290
Religion				
Christian	3548(45.5)	1528(19.6)	1.12(0.91, 1.38)	0.290
Muslim	2043(26.2)	568(7.3)	1.26(1.04, 1.54)	0.020
Others	55(0.7)	51(0.66)	1	

Employed				
Yes	5454(70.0)	2039(26.2)	1.42(1.10, 1.84)	0.007
No	192(2.5)	108(1.4)	1	
Number of living children				
No children	671(8.6)	157(2.0)	0.99(0.77, 1.27)	0.947
One to two children	1607(20.6)	640(8.2)	1.04(0.86, 1.25)	0.696
Three to five children	2038(26.5)	734(9.4)	1.23(1.03, 1.47)	0.021
Six and above	1331(17.1)	617(7.9)	1	
Wife refusing sexual intercourse				
Yes	4820(61.8)	1680(21.6)	1.52(1.25, 1.84)	< 0.001
No	772(9.9)	444(5.7)	0.79(0.51, 1.23)	0.304
I don't know	54(0.7)	23(0.3)	1	
Have any STI				
Yes	125(1.6)	51(0.7)	0.13(0.01, 2.05)	0.147
No	5518(70.8)	2096(26.9)	0.12(0.01, 1.93)	0.133
I don't know	4(0.04)	0	1	
Ever tested for HIV				
Yes	3111(39.9)	1007(12.9)	1.47(1.26, 1.70)	< 0.001
No	2535(32.5)	1140(14.6)	1	
Frequently watching television				
Not at all	2906(37.3)	1395(17.9)	1	
At least once a week	2741(35.2)	752(9.7)	1.59(1.34, 1.88)	< 0.001
Have a bank account				
Yes	1783(22.9)	504(6.5)	1.29(1.10, 1.55)	0.004
No	3863(49.6)	1643(21.1)	1	
Wealth index				
Poor	2207(28.3)	778(10.0)	1	
Middle	1128(14.5)	423(5.4)	0.96(0.77, 1.19)	0.694
Rich	2312(29.7)	947(12.2)	1.20(0.98, 1.46)	0.073
Place of residence				
Urban	946(12.1)	317(4.1)	1	
Rural	4700(60.3)	1830(23.5)	0.54(0.38, 0.78)	0.001
Region				
Agrarian	5117(65.7)	1966(25.2)	1	
Pastoralist	235(3.0)	137(1.8)	0.30(0.21, 0.43)	< 0.001
Metropolises	294(3.8)	44(0.6)	2.12(1.38, 3.26)	0.001

HIV-Human immunodeficiency virus; STI-Sexually transmitted infection

Table 3: Multilevel multivariable logistic regression analysis of substance use among ever-married men by individual and community level determinants from 2016 EDHS data (n = 7793)

Variables	Model I (null model)	Model II	Model III	Model IV
		Individual-level variables	Community-level variables	Individual and community-level variables

Age of the respondents			
15-24	1		1
25-34	1.65(1.25, 2.17)**		1.61(1.22, 2.12)**
35-44	1.90(1.39, 2.59)**		1.81(1.33, 2.47)**
>=45	1.87(1.34, 2.61)**		1.74(1.24, 2.43)
Educational status			
No formal education	1		1
Primary education	0.98(0.82, 1.17)		0.96(0.80, 1.15)
Secondary and above education	0.64(0.50, 0.81)**		0.63(0.49, 0.80)**
Religion			
Christian	1		1
Muslim	0.93(0.74, 1.16)		1.03(0.82, 1.30)
Others	1.52(0.81, 2.87)		1.52(0.81, 2.85)
Employed			
Yes	1.40(1.10, 1.81)*		1.34(1.04, 1.74)*
No	1		1
Number of living children			
No children	1.33(0.98, 1.81)		1.24(0.91, 1.69)
One to two children	1.20(0.94, 1.51)		1.12(0.88, 1.41)
Three to five children	1.29(1.10, 1.56)*		1.24(1.03, 1.50)*
Six and above	1		1
Wife refusing sexual intercourse			
No	1.29(0.83, 2.00)		1.19(0.77, 1.85)
Yes	1.80(1.18, 2.74)*		1.66(1.10, 2.52)*
I don't know	1		1
Have any STI			
Yes	0.86(0.49, 1.54)		0.83(0.47, 1.48)
No	9.30(0.66, 25.68)		9.16(0.63, 24.79)
I don't know	1		1
Ever tested for HIV			
Yes	1.40(1.18, 1.63)**		1.38(1.18, 1.63)**
No	1		1
Frequently watching television			
Not at all	1		1
At least once a week	1.55(1.30, 1.87)**		1.49(1.24, 1.79)**
Have a bank account			
Yes	1.13(0.93, 1.38)		1.10(0.91, 1.35)
No	1		1
Wealth index			

Poor		1		1
Middle		0.91(0.73, 1.13)		0.84(0.67, 1.04)
Rich		1.01(0.81, 1.26)		0.88(0.70, 1.10)
Place of residence				
Urban			1	1
Rural			0.93(0.62, 1.40)	1.12(0.72, 1.75)
Region				
Agrarian			1	
Pastoralist			0.30(0.21, 0.43)**	0.36(0.25, 0.52)**
Metropolises			2.02(1.22, 3.35)*	2.30(1.38, 3.82)*
Measure of variation				
Community level variance (Se)	3.61(0.084)*	2.10(0.083)**	1.97 (0.078)**	1.56(0.079)**
ICC % (95% CI)	52.2(47.9, 56.6)	50.1(45.7, 54.6)	48.1(43.6, 52.5)	47.2(42.7, 51.7)
PCV (%)	Reference	41.8	45.4	56.8
MOR	3.44	2.00	1.88	1.49
Model selection				
Log-likelihood	-3501.14	-3440.65	-3459.51	-3408.09
AIC	7006.27	6925.31	6929.03	6866.18
BIC	7020.14	7077.85	6963.70	7039.52

AIC- Akaike's Information Criterion, BIC- Bayesian Information Criterion, ICC- Intra-Cluster Correlation, PCV -Proportional Change in Variance, SE Standard Error, MOR, median odds ratio; AOR-Adjusted Odds Ratio; *p-value < 0.05, **p-value < 0.001

Discussions

Using the 2016 EDHS dataset, this study was done to investigate the magnitude and determinants of substance use among ever-married men in Ethiopia. The overall prevalence of substance usage was 72.5 percent in this study, with 59.6 percent using only one substance. This study finding was slightly higher than the previous study conducted in Ethiopia²⁰ and in sub-Saharan Africa.³⁵ This might be due to the difference in the age of participants, duration of the study, and sample size. Around 12.9% of the respondents were two and above substance users, which is lower than a previous study conducted in Ethiopia³⁶ and studies conducted in the USA³⁷, Scotland³⁸, and United Arab Emirates³⁹. The discrepancy in magnitude of substance use can be explained in relation to characteristics of the respondents, accessibility of the substances, and social desirability bias. Moreover, most injectable substances which are not readily available might limit the variety of substances used. Cigarettes (7.4 percent), khat (31.6 percent), and alcohol (47.8 percent) were the most often utilized substances in ascending order. In terms of khat use, the results were lower than those found in prior

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3 268 studies in Ethiopia ⁴⁰⁻⁴², Yemen ⁴³, and Uganda ⁴⁴. This wide range of results could be attributable to
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5 269 differences in sample size, study duration, and study participant characteristics. The DHS, on the
6
7 270 other hand, was conducted among a large population and described as an amalgamation of the
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9 271 country's most remote and urbanized locations. Alcohol was one of the most commonly utilized
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11 272 substances in this survey. This finding was in line with research conducted in Ethiopia ^{18,45}, but it was
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13 273 at odds with findings from Bangladesh ⁴⁶, the United States⁴⁷, and Morocco⁴⁸, where the cigarette was
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15 274 widely used. The disparity could be due to the method employed to examine alcohol and media
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17 275 advertising, as well as socioeconomic differences. In Ethiopia, there is a wide range in substance use
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19 276 by regions. The Amhara and Oromiya regions had greater percentages of substance users, which was
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21 277 consistent with earlier findings in Ethiopia.^{20, 49} Differences in substance usage by geographic region
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23 278 could be attributable to socioeconomic level, availability, and accessibility of substances. Individual
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25 279 and community-level determinants such as current age of ever-married men, attending secondary and
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27 280 higher education, being employed, the number of living children, sexual incompatibility with their
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29 281 wife, ever tested for HIV, frequently watching television, living in metropolises (city), and pastoralist
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31 282 region was found to have a statically significant effect based on the multilevel logistic regression
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33 283 analysis. In comparison to men between the ages of 15 and 24, the odds of substance use were higher
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35 284 among ever-married men between the ages of 25 and 34. This finding was in line with a previous
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37 285 study conducted in Ethiopia.^{20, 40, 49, 50} This could be because the likelihood of substance abuse rises as
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39 286 people live longer and have more life experiences. ^{51, 52} Secondly, young individuals may be reliant
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41 287 on their family, which lessens the pre-arranged condition to using substances, such as the ability to
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43 288 purchase them. When compared to men who had no formal education, ever-married men with a
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45 289 secondary or higher education had a lower risk of substance use. This finding is comparable with a
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47 290 study finding in Saudi Arabia.⁵³ The possible explanation of this finding might be due to illiterate
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49 291 men would have a lack of information on the negative consequences of substance use on their health
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51 292 and more educated men may have limited time to use a substance. The probabilities of substance use
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53 293 were higher among working ever-married males than among jobless men, which is consistent with
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55 294 prior Ethiopian research [23, 40]. It's possible that this is related to the fact that unemployed people
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57 295 can't afford to buy substances. When compared to their counterparts, the odds of substance use were
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59 296 higher among ever-married men who had a sexual incompatibility with their wives. This could be
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61 297 explained by the fact that when there is sexual satisfaction between two partners, there is a chance
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63 298 that men will use substances to cope with the stress. On the other hand, ever-married men who had

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3 299 ever tested for HIV had a higher risk of substance use. The respondents tested for HIV, might be due
4 300 to they suspect themselves regarding risky sexual practice with others sexual partners may exist after
5 301 using substances. Similarly, ever-married males who watched television at least once a week had a
6 302 higher risk of substance use than those who did not watch TV at all. This result was in line with a
7 303 previous study [20]. This could be because some substances, such as alcohol, are heavily promoted in
8 304 the media (television). Substance use was more common among ever-married men who lived in
9 305 metropolises (city) regions than among those who lived in agrarian regions. Furthermore, ever-
10 306 married men living in the pastoralist zone had lower odds of substance usage than those living in the
11 307 agrarian regions. This finding was in line with earlier Ethiopian research [40, 54]. Disparities in
12 308 substance usage by geographical region may be attributable to differences in substance distribution,
13 309 accessibility, production, marketing, and other cultural elements of Ethiopian men [55, 56].

310 **Conclusion**

311 Despite the limitations mentioned above, the overall magnitude of substance use among Ethiopian
312 ever-married men was found to be substantial. Alcohol was by far the most often used substance.
313 There was a disparity in the magnitude of substance usage by geographic region, with Amhara and
314 Oromiya having the greatest percentages. Individual and community-level determinants such as
315 current age, secondary and higher education, employment, number of living children, HIV testing
316 history, sexual incompatibility with their wife, frequent television watching; living in metropolises,
317 and pastoralist regions were found to have a statistically significant relationship with substance use.
318 Given these findings, it is critical to lessen the problem by improving modifiable individual-level
319 variables such as educational status, reducing sexual incompatibility with their wife, and reducing
320 substance advertising through mass media.

321 **Contributors:** DZ and MM- Study design, Data analyses and interpretation; AY and AA -Drafting
322 the manuscript; DZ and MM -Critical revision of manuscript. Finally, all authors approved the
323 revised manuscript.

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326 **Competing interests**

327 None declared.

328 **Patient consent for publication**

329 Not applicable.

330 **Ethical considerations and data set access**

331 Demographic and Health Surveys in Ethiopia were done after obtaining ethical clearance from
332 Ethiopia Health and Nutrition Research Institute Review Board, the Ministry of Science and
333 Technology, the Institutional Review Board of ICF International, and the CDC [28]. The entire
334 procedure of the survey, with the organization of actions, questionnaire design, data collectors
335 training, supervisors, and all people involved in the procedure and report writing, were strictly
336 followed. Data were collected after taking informed consent, and all information was kept
337 confidential. For these detailed research activities, consent was given by the Demographic and Health
338 Surveys Program project to access 2016 EDHS data after evaluation of the submitted summary of the
339 planned study. All the ethical concerns, including informed consent, anonymous are followed [28].

340 **Availability of data and materials**

341 The manuscript contains all of the important findings, and all data used for the statistical analysis is
342 publicly available (www.dhsprogram.com). "Because we used 2016 EDHS data, we are not
343 authorized to share the data with a third party." Furthermore, the 'Dataset Terms of Use' prohibit us
344 from distributing this data following data access rules (<http://dhs.gov>).

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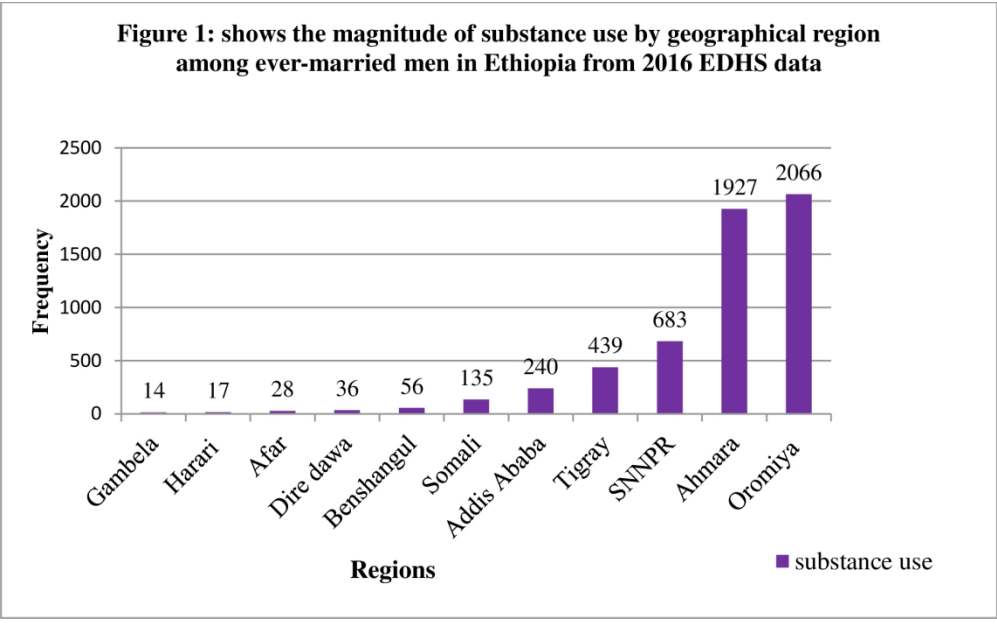
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493 **Figure Legends**

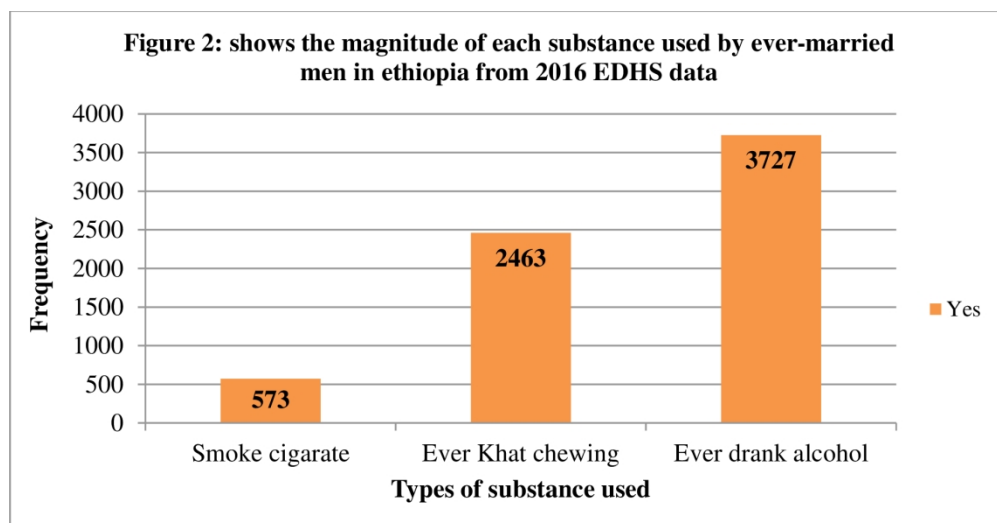
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36 494 **Figure 1:** shows the magnitude of substance use by geographical region among ever-married men in
37 Ethiopia from 2016 EDHS data
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40 496 **Figure 2:** shows the magnitude of each substance used by ever-married men in Ethiopia from 2016
41 EDHS data
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Geographical variation and correlates of substance use among married men in Ethiopia: Spatial and multilevel analysis

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Keywords:	Substance misuse < PSYCHIATRY, PRIMARY CARE, Health economics < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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3 1 **Geographical variation and correlates of substance use among married men in**
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5 2 **Ethiopia: Spatial and multilevel analysis**
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23 Abstract

24 **Objective:** The use of substances has become one of the world's most serious public health and
25 socioeconomic issues. Most nations in Sub-Saharan Africa, including Ethiopia, are currently
26 undergoing significant economic and cultural transitions, which have created a favorable environment
27 for socially destructive substance use. The objective of this study was to determine the prevalence and
28 correlates of substance use among ever-married men in Ethiopia.

29 **Design:** A community-based cross-sectional survey was undertaken from January 18 to June 27, 2016.

30 **Data source:** Data was used from the 2016 Ethiopian demographic and health survey (EDHS).

31 **Data extraction and Analysis:** Data from the 2016 EDHS was used and a total of 7793 ever-married
32 men were involved in the analysis. The spatial autocorrelation statistic (Global Moran's I) was used to
33 determine whether substance use was dispersed, clustered, or randomly distributed. A multi-level
34 logistic regression model was used to identify the correlates with substance use, and statistical
35 significance was declared at p-value < 0.05 and 95% CI.

36 **Results:** Of all ever-married men, 72.5% (95% CI 71.5, 73.4%) of them were currently used at least
37 one of the three substances (alcohol, cigarettes, and Chat). The highest hotspot areas of substance use
38 were observed in Harari and Dire Dawa regions. The age (AOR = 1.81; 95% CI: 1.33, 2.47),
39 educational status (AOR = 0.63; 95%CI: 0.49, 0.80), occupation (AOR = 1.34; 95%CI: 1.04, 1.74),
40 watching television (AOR = 1.49; 95%CI 1.24, 1.79), and living in the city (AOR = 2.30; 95%CI: 1.38,
41 3.82) were individual and community-level correlates found to have a statistically significant
42 association with substance use.

43 **Conclusion:** In this study, nearly three-fourths of married men used one of the three substances. Given
44 these findings, it is critical to reduce the problem by improving modifiable individual-level variables
45 such as educational status and reducing substance advertising.

46 **Keywords;** Ever-married men, Substance use, EDHS, Multilevel, Ethiopia

50 **Strength and limitations of the study**

- 51 ➤ This study used a nationally representative large sample size.
- 52 ➤ The frequency and dose of substances consumed were not considered in the study.
- 53 ➤ The clinical characteristics and the effects of addiction to these substances were not measured.
- 54 ➤ The extent of substance usage was determined through self-reported.
- 55 ➤ The study considered the most frequently used substances like alcohol, cigarettes, and chat.

56 **Introduction**

57 The continued use of alcohol, tobacco, chat, caffeine, illegal narcotics, and inhalants with negative
58 consequences is referred to as substance use. Problematic substance use is defined as having a strong
59 desire to use the substance, having difficulty controlling how much or how frequently the substance is
60 used, having urges to use the substance, and continuing to use the substance despite negative
61 consequences [1, 2]. Substance abuse disorder can be caused by genes, drug action, peer pressure,
62 emotional distress, anxiety, depression, and environmental stress [3, 4].

63 Globally, there are 2 billion alcohol users, 1.3 billion smokers, and 185million drug users [5, 6].
64 Alcohol and tobacco (cigarettes) are the most commonly used substances across all age groups and
65 constitute a significant contributor to the worldwide burden of diseases [7-10]. Most nations in Sub-
66 Saharan Africa are currently undergoing significant economic, social, and cultural transitions, which
67 have created a favorable environment for increased and socially destructive substance use [11]. Nearly
68 42% of people in Sub-Saharan Africa used "any substance," with the highest percentage (55.5%) in
69 Central Africa. Males are more likely than females to engage in substance use behavior [7, 12].
70 Substance uses among young adults, is associated with physical and psychosocial problems like
71 fighting, damage, robbery, engaging in unguarded sex, personal injury, medical problems, and impaired
72 relationships with family and friends [13-15].

73 The substances use has become one of the world's most serious public health, disastrous health,
74 socioeconomic issues and environmental consequences [5].⁵ The substance abuse accounts for 5.4% of
75 the global disease burden and estimated to cost the world 28 million lost years of healthy living
76 (disability-adjusted life years) [16, 17]. Alcohol and tobacco use have also been linked to an increased
77 risk of chronic diseases such as cancer, chronic pulmonary disease, diabetes, accidents, violence,
78 cancer, and liver cirrhosis. On the other hand, Regular chat use causes gingivitis, tooth loss,

79 gastrointestinal problems, cardiac complications, male impotence, insomnia, and a variety of mental
80 health issues [16-20].

81 Prior research conducted in Ethiopia on a small and large scale found that substance use ranged from
82 23.86 to 62.50% [21-25]. On the other hand, social mobility, accessibility, low wealth, low level of
83 education, lower socioeconomic groupings, increasing age, employment, and stressful life events were
84 factors of substance use (chat, cigarettes, and alcohol). Other motivations for substance use have been
85 discovered, such as improved well-being, euphoria, excitement, social participation, increased
86 alertness, stress reduction, increased capacity to focus, and addiction [22-28].

87 Substance abuse endangers people's health as well as their social and economic well-being [5, 29, 30].
88 To counteract these dangers; Ethiopia's government implemented a mandatory policy and raised taxes
89 on regularly used substances. Alcohol advertising is now forbidden in Ethiopia, according to
90 proclamation No. 759/2012, when the alcoholic content exceeds 12% [31]. Even though we have a
91 proclamation to manage substance use, there is still significant difficulty with its execution, as well as
92 limited evidence about the extent of substance use and its correlates. To the best of our knowledge there
93 is no study on substance usage among Ethiopian ever-married men. Thus, this study was designed to
94 determine the magnitude and correlates of substance use among ever-married men in Ethiopia using the
95 2016 EDHS.

96 **Review questions**

- 97 ➤ What is the magnitude of substance use among ever-married men in Ethiopia?
- 98 ➤ What are the significant correlates of substance use among ever-married men in Ethiopia?

99 **Methods**

100 **Patient and public involvement**

101 This study had no direct patient or public engagement.

102 **Study setting and design**

103 Ethiopia is Africa's second-most populated country, with 117.7 million people and divided into three
104 metropolitan (city) and nine non-metropolitan regions [32, 33]. According to the 2016 EDHS report,
105 roughly 61.4 % of the men in the study have ever-married. A community-based cross-sectional survey
106 was undertaken from January 18 to June 27, 2016 [33].

107 **Data source and population**

1
2
3 108 In this study, data from the 2016 EDHS were used, specifically male dataset.
4

5 109 **Sample size and sampling methods**

6
7 110 The entire demographic and health survey sample was designed to represent all of the country's regions
8 111 and administrative cities. In Ethiopian health and demographic survey (2016), two-phase sample
9 112 procedures were used, with clusters being picked in the first phase and households being selected in the
10 113 second [34]. Every region was divided into two stratum: urban and rural. The sample size was then
11 114 allocated using a probability proportional allocation method. The survey included around 645 clusters,
12 115 with 200 from the urban and 443 from the rural. As a result, the study included a total of 7793 ever-
13 116 married men, with 1,262 from the urban and 6,531 from the rural.
14

15 117 **Data collection tool and quality assurance**

16 118 The fundamental three data collection tools for the DHS were adopted from the demography and health
17 119 survey project. These data collection tools include questions for the household, women, and men [33].
18 120 The data for this study came from the survey's men's questionnaire. The data questionnaire was first
19 121 written in English and then translated into the three main local languages: Amharic, Afan Oromo, and
20 122 Tigrigna. A pretest was conducted before data collection, and all data collectors, supervisors, and
21 123 quality controllers who took part in the surveys received training.
22

23 124 **Operational definition**

24 125 **An ever-married man; is a man who has been married at least once in their life or on the date of data**
25 126 **collection.**

26 127 **Substance use** is defined as a self-report of exposure to at least one of the three substances (alcohol,
27 128 chat, tobacco) before the interview irrespective of its dose and frequency (yes/no) [35].

28 129 **Study variable and measurements**

29 130 **Outcome variable**

30 131 Substance use is the outcome variable with two category (yes = 1 when a substance is used and no = 0
31 132 if no substance is used). Substance use was determined to depend on the ever-married men's self-report
32 133 using a single item for each substance. 'Do you currently smoke or use any other type of tobacco every
33 134 day, some days, or not at all?' As a result, anyone who reported every day or some days was taken as a
34 135 current smoker. Chat chewing and alcohol use behaviors were also determined using: 'During the last
35 136 30 days, how many days did you chew chat?' and 'During the last 30 days, how many days did you
36 137 have a drink that contains alcohol?' In both issues, anybody who described at least one day of use in the
37 138 former 30 days was taken as current chat and alcohol users', respectively [33]. The magnitude of
38

1
2
3 139 substance use was calculated by dividing the total number of substance users (obtained from a
4 140 composite score of three substances) by the total number of ever-married men from the 2016 EDHS.

7 141 **Independent variables**

9 142 The individual and community-level independent variables were included. **Individual-level variables**
10 143 involve men's current age (15-24, 25-34, 35-44, >=45 years), educational status (no formal education,
11 144 primary, secondary, and above), religion (Christian, Muslim, and others), Occupation (employed, not
12 145 employed), a number of living children (0, 1-2, 3-5, >=6), wealth index (poor, middle and rich), land
13 146 ownership (yes, no), housing ownership (yes, no), wife refusing sexual intercourse/sexual
14 147 incompatibility (yes, no), had any STI (yes, no), ever tested for HIV (yes, no), Frequently watching
15 148 television(not at all, at least once a week), have a bank account(yes, no). **Community-level variables**
16 149 include place of residence (urban, rural) and regions recoded into agrarian, pastoralist, and metropolises
17 150 (city). The agrarian region is obtained by recoding the Tigray, Amhara, Oromiya, and South Nation
18 151 Nationality People's Republic (SNNPR) regions; the pastoralist region involves Afar, Somali,
19 152 Benishangul, and Gambella regions. The metropolises (city) administration regions include Harari,
20 153 Addis Ababa, and Dire Dawa. Residents' living stability and social change index were used to combine
21 154 these regions. The regions considered a city (metropolis) have a greater social change index than other
22 155 regions. The pastoral regions originated in the lowland areas of Ethiopia, mostly traveling from place to
23 156 place with their cattle to find grass and water. The agrarian regions originated in the highland area of
24 157 the country, in which agriculture is the principal work.

25 158 **Data extraction and analysis**

26 159 STATA software version 14 was used to analyze the data. The weighted samples were employed in
27 160 data analysis to ensure that the survey results were representative of national and regional findings. To
28 161 ensure the survey's representativeness by region and account for non-response, data were weighted
29 162 using the men's data weighting variable (mv005/10⁶) as recommended by the DHS. Using STATA 'svy'
30 163 function, the analysis was also employed to describe the complex survey design and resilient standard
31 164 errors (stratification and clustering). Tables and graphs were used to generate and organize descriptive
32 165 statistics such as frequency and percentage. Individual and community-level variable frequencies were
33 166 calculated in relation to the outcome variable. The correlates of substance use were identified using a
34 167 multi-level logistic regression model. At the same time, four models were fitted to estimate the fixed
35 168 influence of both individual and community level correlates as well as the random effect of cluster

1
2
3 169 fluctuations. First, the null model was run without any correlates. The effect of individual-level
4
5 170 correlates on substance use was estimated using the second model. The third model was used to
6
7 171 examine the effect of community-level correlates with substance use. Finally, the fourth model was run
8
9 172 to estimate the combined effects of individual and community level correlates. The proportional change
10
11 173 in variance (PCV) was computed using the community-level variance in the null model as the
12
13 174 denominator, which is the proportion of total community-level variance explained by individual and
14
15 175 community-level variables. The Intra-Cluster Correlation (ICC) was determined to indicate random
16
17 176 effects within a model [36, 37]. Akaike's Information Criterion (AIC) and Bayesian information criteria
18
19 177 (BIC) were used for model selection. Each value of AIC and BIC in all models with the lowest value
20
21 178 was considered [38, 39]. The median odds ratio (MOR) was calculated to indicate mysterious cluster
22
23 179 heterogeneity [36]. Variables having *P*-value up to 0.25 in the bivariable logistic regression analysis
24
25 180 were considered to fit multivariable logistic regression analysis. Variance inflation factor was used to
26
27 181 notice multicollinearity within individual-level correlates. The fixed effects of individual and
28
29 182 community level correlates on substance use were stated using an adjusted odds ratio (AOR) with 95%
30
31 183 confidence intervals (CI). Accordingly, the final (4th model) was used to designate the combined effect
32
33 184 of individual and community-level correlates on substance use among ever-married men. A *P*-value <
34
35 185 0.05 and an adjusted odds ratio with 95% confidence intervals were considered to declare statistical
36
37 186 significance. The moderation analysis was performed to determine whether community-level variables
38
39 187 moderated individual-level variables.

37 188 **Spatial autocorrelation analysis**

38
39 189 The spatial statistics tool was used to perform the spatial analysis in this study (ArcGIS Version 10.3;
40
41 190 Redlands, California, United States). The spatial autocorrelation statistic (Global Moran's I) was used to
42
43 191 determine whether substance use was dispersed, clustered, or randomly distributed. The cluster and
44
45 192 outlier analysis were used to examine the spatial heterogeneity of substance use enumeration areas as
46
47 193 high and low. The cold and hotspot areas of substance use was indicated using the Getis-Ord G_i^*
48
49 194 statistics and related *Z*-scores. Furthermore, the spatial interpolation analysis was used to predict the
50
51 195 not sampled or unmeasured value from sampled measurements using the kriging ordinary interpolation.

52 196

53
54 197

198

199 Results

200 Socio-demographic characteristics of ever-married men

201 The analysis included a total of 7793 ever-married men from the 2016 demographic and health survey.
 202 The men's mean age (standard deviation) was 37.3 (± 9.7), and 42% of ever-married men had never
 203 attended formal education. The Oromiya region had about 38% of ever-married men, and 83.8% of
 204 them lived in rural areas. The majority of men who had ever married had three to five living children,
 205 and 96.1% of ever-married men were actively employed. (Table 1)

206 **Table 1: Socio-demographic characteristics of ever-married men in Ethiopia using 2016 DHS**
 207 **(n= 7,793)**

Variables	Weighted frequency	%
Age of the respondents		
15-24	566	7.3
25-34	2745	35
35-44	2484	32
>=45	1998	25
Educational status		
No formal education	3284	42
Primary education	3179	40
Secondary and above education	1329	17
Religion		
Christian	5076	65
Muslim	2610	34
Others*	106	1
Occupation		
Employed	7492	96.1
Not employed	300	3.9
Number of living children		
No children	827	10.6
One to two children	2247	28.8
Three to five children	2771	35.6
Six and above	1948	25.0
Wealth index		
Poorest	1366	17.5
Poorer	1617	20.8
Middle	1550	19.9
Richer	1584	20.3
Richest	1674	21.5

8

Place of residence		
Urban	1262	16.2
Rural	6530	83.8
Region		
Harari	19	0.25
Gambella	21	0.3
Dire Dawa	41	0.5
Afar	59	0.8
Benishangul Gumuz	84	1.1
Somali	208	2.7
Addis Ababa	278	3.6
Tigray	461	5.9
SNNPR	1570	20.1
Amhara	2090	26.8
Oromiya	2961	38.0

*traditional religion, "wakefata"

The magnitude of substance use

In this study, one of the three substances namely alcohol, cigarette, and Chat was currently used by 72.5% (95% CI 71.5, 73.4%) of the ever-married men. About 59.6%, 11.8%, and 1.1% of ever-married men used one, two, and all of the three substances, respectively. Alcohol (48.4%) and chat (31.9%) were the most commonly used substance by ever-married men. Almost two-thirds (73%) of ever-married men aged 25-34 years were found to be using one of the three substances. Married men with no formal education were found to use one of the three substances at a higher rate (78.3%). In contrast, 72.8% of employed married men used one of the three substances. Besides, married men living in rural and agrarian regions used one of the three substances at a similar rate (72%). (Table 2)

Spatial distribution of substance use in Ethiopia

The spatial autocorrelation analysis revealed that the spatial distribution of substance use in Ethiopia was clustered. The Global Moran's I value of 0.403 (p-value < 0.001) indicated that substance use was significantly clustered in Ethiopia (Supplementary file 1 and 2 figures). Clusters with high proportion of substance use were from Tigray and Amhara regions whereas clusters with low proportion of substance use were observed in Sidama (North, West, and East), and Oromiya (Southwest), Addis Ababa, Gambella and Benishangul Gumuz (Fig 1).

In this study, ordinary kriging interpolation analysis was used to predict the magnitude of substance use. Accordingly, the high levels of substance use were observed in Amhara, Oromiya, Addis Ababa

227 and Somali regions. On the other hand, the low substance use areas were predicted in the SNNP,
228 Sidama, and Somali regions (Fig 2).

229 **Hotspot detection of substance use**

230 The highest proportions of substance use among ever-married men were reported from Tigray and
231 Ahmara regions, similarly the highest hotspot areas of substance use were observed in Tigray, Ahmara,
232 Addis Ababa, Harari and Dire Dawa regions. On the other hand, the cold spot area of substance use
233 was seen in Benishangul Gumuz, Gambella, SNNPR, Sidama and southwest people of Ethiopia regions
234 (Fig.3).

235 **Correlates of substance use**

236 We have conducted a multilevel logistic regression analysis using the 2016 EDHS to identify the
237 individual and community-level correlates with substance use. The interclass-correlation in the empty
238 model showed 52.2% variability in the magnitude of substance use among ever-married men
239 recognized to the difference between clusters in the community. Additionally, the variability among
240 clusters in Model II was 50.1%, 48.1% in Model III, and 47.2% in Model IV. The proportion of change
241 in the variance was 41.8% for Model II (individual-level correlates), 45.4% for Model III (community-
242 level correlates), and 56.8% for Model IV (combined individual-and community-level correlates) in
243 which addition of the correlates to empty model well explained within three models, particularly in the
244 final model. In moderation analysis, only the occupation of respondents was significantly moderated by
245 region (Supplementary file 3-6 tables).

246 **Individual-level correlates:** The odds of substance use were 61 and 81% higher among ever-married
247 men who were in the age category of 25-34 (AOR = 1.61; 95% CI: 1.22, 2.12) and 35-44 (AOR = 1.81;
248 95% CI: 1.33, 2.47) in relation to men within the age category of 15-24 years old. The ever-married
249 men who had attended secondary and above education were 37% less likely to use substances
250 compared to men who had no formal education (AOR = 0.63; 95% CI: 0.49, 0.80). The odds of
251 substance use were 24% higher among ever-married men who had 3 to 5 living children in relation to
252 their counterparts (AOR = 1.24; 95% CI: 1.03, 1.50). The odds of substance use among employed ever-
253 married men were 34% higher with unemployed men (AOR = 1.34; 95% CI: 1.04, 1.74). The odds of
254 substance use were 66% higher among ever-married men who had a sexual incompatibility with their
255 wives compared to their counterparts (AOR = 1.66; 95% CI 1.10, 2.52). On the other hand, ever-

256 married men who had ever tested for HIV were obtained to have 38% higher odds of substance use than
 257 their counterparts (AOR = 1.38; 95% CI 1.18, 1.63). Similarly, the ever-married men who were
 258 watching television at least once a week had 49% higher odds of substance use compared to their
 259 counterparts (AOR = 1.49; 95% CI 1.24, 1.79).

260 **Community-level correlates:** The odds of substance use among ever-married men who were living in
 261 the metropolises (city) regions were 2.3 times more likely than those who were living in the agrarian
 262 regions (AOR = 2.30; 95% CI: 1.38, 3.82). Besides, there were 64% lower odds of substance use
 263 among ever-married men living in the pastoralist region compared to those living in the agrarian
 264 regions (AOR = 0.36; 95% CI: 0.25, 0.52). (Table 3)

265 **Table 2: Multilevel bivariable logistic regression analysis of substance use among married men in**
 266 **Ethiopia using the 2016 EDHS (n = 7793)**

Variables	Substance use		COR 95% CI	P-value
	Yes n (%)	No n (%)		
Age of the respondents				
15-24	383(67.7)	183(32.3)	1	
25-34	1998(72.8)	748(27.2)	1.62(1.25, 2.10)	< 0.001
35-44	1818(73.2)	666(26.8)	1.81(1.39, 2.35)	< 0.001
>=45	1447(72.4)	551(27.6)	1.61(1.23, 2.12)	0.001
Educational status				
No formal education	2571(78.3)	713(21.7)	1	
Primary education	2186(68.8)	994(31.2)	1.13(0.96, 1.33)	0.157
Secondary and above education	889(66.9)	440(33.1)	0.89(0.73, 1.10)	0.290
Religion				
Christian	3548(69.9)	1528(30.1)	1.12(0.91, 1.38)	0.290
Muslim	2043(78.3)	568(21.8)	1.26(1.04, 1.54)	0.020
Others	55(51.8)	51(48.2)	1	
Occupation				
Employed	5454(72.8)	2039(27.2)	1.42(1.10, 1.84)	0.007
Not Employed	192(64)	108(36)	1	
Number of living children				
No children	671(81.1)	157(18.9)	0.99(0.77, 1.27)	0.947
One to two children	1607(71.5)	640(28.5)	1.04(0.86, 1.25)	0.696
Three to five children	2038(73.5)	734(26.5)	1.23(1.03, 1.47)	0.021
Six and above	1331(68.3)	617(31.7)	1	
Wife refusing sexual intercourse				
Yes	738(75.5)	240(24.5)	1.52(1.25, 1.84)	< 0.001
No	4909(72)	1907(28)	0.79(0.51, 1.23)	0.304
Have any STI				
Yes	125(71.0)	51(29)	0.13(0.01, 2.05)	0.147

No	5518(72.5)	2096(27.5)	0.12(0.01, 1.93)	0.133
I don't know	4(100)	0	1	
Ever tested for HIV				
Yes	3111(75.5)	1007(24.5)	1.47(1.26, 1.70)	< 0.001
No	2535(69)	1140(31)	1	
Frequently watching television				
Not at all	2906(67.6)	1395(32.4)	1	
At least once a week	2741(78.5)	752(21.5)	1.59(1.34, 1.88)	< 0.001
Have a bank account				
Yes	1783(78)	504(22)	1.29(1.10, 1.55)	0.004
No	3863(70.2)	1643(29.8)	1	
Wealth index				
Poor	2207(74)	778(26)	1	
Middle	1128(72.7)	423(27.3)	0.96(0.77, 1.19)	0.694
Rich	2312(70.9)	947(29.1)	1.20(0.98, 1.46)	0.073
Place of residence				
Urban	946(74.9)	317(25.1)	1	
Rural	4700(72)	1830(28)	0.54(0.38, 0.78)	0.001
Region				
Agrarian	5117(72.2)	1966(27.8)	1	
Pastoralist	235(63.2)	137(36.8)	0.30(0.21, 0.43)	< 0.001
Metropolises	294(87)	44(13)	2.12(1.38, 3.26)	0.001

267 *HIV-Human immunodeficiency virus; STI-Sexually transmitted infection*

268 **Table 3: Multilevel multivariable logistic regression analysis of substance use among ever-**
 269 **married men by individual and community level correlates from 2016 EDHS data (n = 7793)**

Variables	Model I (null model)	Model II	Model III	Model IV
		Individual-level variables	Community-level variables	Individual and community-level variables
Age of the respondents				
15-24		1		1
25-34		1.65(1.25, 2.17)**		1.61(1.22, 2.12)**
35-44		1.90(1.39, 2.59)**		1.81(1.33, 2.47)**
>=45		1.87(1.34, 2.61)**		1.74(1.24, 2.43)
Educational status				
No formal education		1		1
Primary education		0.98(0.82, 1.17)		0.96(0.80, 1.15)
Secondary and above education		0.64(0.50, 0.81)**		0.63(0.49, 0.80)**
Religion				
Christian		1		1
Muslim		0.93(0.74, 1.16)		1.03(0.82, 1.30)
Others		1.52(0.81, 2.87)		1.52(0.81, 2.85)

Occupation				
Employed		1.40(1.10, 1.81)*		1.34(1.04, 1.74)*
Not employed		1		1
Number of living children				
No children		1.33(0.98, 1.81)		1.24(0.91, 1.69)
One to two children		1.20(0.94, 1.51)		1.12(0.88, 1.41)
Three to five children		1.29(1.10, 1.56)*		1.24(1.03, 1.50)*
Six and above		1		1
Wife refusing sexual intercourse				
Yes		1.92(1.15, 2.84)*		1.85(1.13, 2.67)*
No		1		1
Have any STI				
Yes		0.86(0.49, 1.54)		0.83(0.47, 1.48)
No		9.30(0.66, 25.68)		9.16(0.63, 24.79)
I don't know		1		1
Ever tested for HIV				
Yes		1.40(1.18, 1.63)**		1.38(1.18, 1.63)**
No		1		1
Frequently watching television				
Not at all		1		1
At least once a week		1.55(1.30, 1.87)**		1.49(1.24, 1.79)**
Have a bank account				
Yes		1.13(0.93, 1.38)		1.10(0.91, 1.35)
No		1		1
Wealth index				
Poor		1		1
Middle		0.91(0.73, 1.13)		0.84(0.67, 1.04)
Rich		1.01(0.81, 1.26)		0.88(0.70, 1.10)
Place of residence				
Urban			1	1
Rural			0.93(0.62, 1.40)	1.12(0.72, 1.75)
Region				
Agrarian			1	
Pastoralist			0.30(0.21, 0.43)**	0.36(0.25, 0.52)**
Metropolises			2.02(1.22, 3.35)*	2.30(1.38, 3.82)*
Measure of variation				
Community level variance (Se)	3.61(0.084)*	2.10(0.083)**	1.97 (0.078)**	1.56(0.079)**
ICC % (95% CI)	52.2(47.9, 56.6)	50.1(45.7, 54.6)	48.1(43.6, 52.5)	47.2(42.7, 51.7)
PCV (%)	Reference	41.8	45.4	56.8
MOR	3.44	2.00	1.88	1.49

Model selection				
Log-likelihood	-3501.14	-3440.65	-3459.51	-3408.09
AIC	7006.27	6925.31	6929.03	6866.18
BIC	7020.14	7077.85	6963.70	7039.52

270 *AIC- Akaike's Information Criterion, BIC- Bayesian Information Criterion, ICC- Intra-Cluster Correlation,*
 271 *PCV -Proportional Change in Variance, SE Standard Error, MOR, median odds ratio; AOR-Adjusted Odds*
 272 *Ratio; *p-value< 0.05, **p-value < 0.001*

273 274 **Discussions**

275 Using the 2016 EDHS, this study was done to investigate the magnitude and correlates of substance use
 276 among ever-married men in Ethiopia. In this study, the overall one of the three substance use was
 277 72.5%, with 59.6 % using only one substance. This study finding was slightly higher than the previous
 278 study conducted in Ethiopia [25] and sub-Saharan Africa [7]. This might be due to the difference in the
 279 age of participants, duration of the study, and sample size. Around 12.9% of the respondents were two
 280 and above substance user, which is lower than a previous study conducted in Ethiopia [40] and studies
 281 conducted in the USA [41], Scotland [42], and United Arab Emirates [43]. The discrepancy in the
 282 magnitude of substance use can be explained by the characteristics of the respondents, socio-economic
 283 status, accessibility of the substances, and social desirability bias. Cigarettes (7.4%), chat (31.6%), and
 284 alcohol (47.8 %) were the most often utilized substances in ascending order. In terms of chat use, the
 285 results were lower than the findings in prior studies conducted in Ethiopia [44-46], Yemen [47], and
 286 Uganda [48]. This wide range of results could be attributable to differences in sample size, study
 287 duration, and study participant characteristics. On the other hand, the DHS was conducted among a
 288 large population and described as an amalgamation of the country's most remote and urbanized
 289 locations. Alcohol was one of the most commonly utilized substances in this survey. This finding was
 290 in line with research conducted in Ethiopia [23, 49], but it was at odds with findings from Morocco
 291 [50], Bangladesh [51], and the United States [52], where the cigarette was widely used. The variation
 292 could be due to the method employed to measure alcohol use and media advertising, as well as
 293 socioeconomic differences. In Ethiopia, there is a wide difference of substance use by regions. The
 294 Amhara and Tigray regions had a greater percentage of substance users (92% vs. 95%, respectively)
 295 which was consistent with earlier findings in Ethiopia [25, 53]. On the other hand, the spatial
 296 autocorrelation analysis of at least one of the three substance use across the regions was observed as a
 297 clustering pattern (Global Moran's I = 0.403, p-value< 0.0001). This indicates that one of the three
 298 substance use in Ethiopia was aggregated in specific areas. Accordingly, the highest hot-spot areas

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3 299 were found in Tigray (central and west), Amhara (central and east), Addis Ababa (central), Harari
4 (west), Dire Dawa (west), and some parts of northwest Benishangul Gumuz region. Differences in
5 300 substance usage by geographic region could be attributable to socioeconomic level, culture, and
6 301 accessibility of substances.
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11 303 Individual and community-level correlates such as current age of ever-married men, attending
12 304 secondary and higher education, being employed, the number of living children, sexual incompatibility
13 305 with their wife, ever tested for HIV, frequently watching television, living in metropolises (city), and
14 306 pastoralist region was found to have a statically significant correlates based on the multilevel logistic
15 307 regression analysis. In comparison to men between the ages of 15 to 24, the odds of substance use were
16 308 higher among ever-married men between the ages of 25 to 34. This finding was in line with a previous
17 309 study conducted in Ethiopia [25, 44, 53, 54]. This could be because the likelihood of substance abuse
18 310 rises as people live longer and have more life experiences [55, 56]. Secondly, young individuals may be
19 311 reliant on their family, which lessens the pre-arranged condition to using substances, such as the ability
20 312 to purchase them. Ever-married men with a secondary or higher education had a lower risk of substance
21 313 use when compared to men who had no formal education. This finding is comparable with a study
22 314 finding in Saudi Arabia [57]. The possible explanation of this finding might be due to illiterate men
23 315 would have a lack of information on the negative consequences of substance use on their health. The
24 316 probabilities of substance use were higher among employed ever-married males than among jobless
25 317 men, which are consistent with prior Ethiopian study findings [28, 44]. This may be related to the fact
26 318 that unemployed people can't afford to buy substances. When compared to their counterparts, the odds
27 319 of substance use were higher among ever-married men who had a sexual incompatibility with their
28 320 wives. This could be explained by the fact that when there is sexual incompatibility between two
29 321 partners, there is a chance that men will use substances to cope with the stress. Similarly, ever-married
30 322 males who watched television (TV) at least once a week had a higher risk of substance use than those
31 323 who did not watch TV at all. This result was in line with a previous study conducted elsewhere.²⁵ This
32 324 could be because some substances, such as alcohol, are heavily promoted in the media (television).
33 325 Substance use was more common among ever-married men who lived in metropolises (city) regions
34 326 than among those who lived in agrarian regions. Furthermore, ever-married men living in the pastoralist
35 327 zone had lower odds of substance use than those living in the agrarian regions. This finding was in line
36 328 with earlier Ethiopian research [44, 58]. Disparities in substance usage by geographical region may be

329 attributable to differences in substance distribution, accessibility, production, marketing, and other
330 cultural elements of Ethiopian men [59, 60].

331 **Conclusion**

332 Despite the limitations mentioned above, nearly three-fourths of ever-married men used one of the three
333 substances. Alcohol was by far the most often used substance. There was a disparity in the magnitude
334 of substance use by geographic region, with Amhara and Tigray having the highest percentages.
335 Individual and community-level correlates such as current age, secondary and higher education,
336 employment, number of living children, HIV testing history, sexual incompatibility with their wife,
337 frequent television watching; living in metropolises(city), and pastoralist regions were found to have a
338 statistically significant relationship with one of the tree substance use. Given these findings, it is critical
339 to lessen the problem by improving modifiable individual-level variables such as educational status,
340 reducing sexual incompatibility with their wife, and reducing substance advertising through mass
341 media.

342 **Contributors:** DZ and MM- Study design, Data analyses, and interpretation; AY and AA -Drafting the
343 manuscript; DZ and MM -Critical revision of the manuscript. Finally, all authors approved the revised
344 manuscript.

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347 **Competing interests**

348 None declared.

349 **Patient consent for publication**

350 Not applicable.

351 **Ethical considerations and data set access**

352 Demographic and Health Surveys in Ethiopia were done after obtaining ethical clearance from Ethiopia
353 Health and Nutrition Research Institute Review Board, the Ministry of Science and Technology, the
354 Institutional Review Board of ICF International, and the CDC [28]. The entire procedure of the survey,
355 with the organization of actions, questionnaire design, data collectors training, supervisors, and all
356 people involved in the procedure and report writing, were strictly followed. Data were collected after

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3 357 taking informed consent, and all information was kept confidential. For these detailed research
4 358 activities, consent was given by the Demographic and Health Surveys Program project to access 2016
5 359 EDHS data after evaluation of the submitted summary of the planned study. All the ethical concerns,
6
7 360 including informed consent, anonymous are followed [28].
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10 361 **Availability of data and materials**

11 362 The manuscript contains all of the important findings, and all data used for the statistical analysis is
12 363 publicly available (www.dhsprogram.com). "Because we used 2016 EDHS data, we are not authorized
13 364 to share the data with a third party." Furthermore, the 'Dataset Terms of Use' prohibit us from
14 365 distributing this data following data access rules (<http://dhs.gov>).
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19 366 **Supplementary Files**

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21 367 *Supplementary file 1 figure*: Global Moran's I Summary and dataset information of substance use
22 368 among married women in Ethiopia, 2016 EDHS.

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24 369 *Supplementary file 2 figure*: Autocorrelation report of substance use among married women in
25 370 Ethiopia, 2016 EDHS.

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27 371 *Supplementary file 3-6 Tables*: Moderator Analysis (PDF)

28 372 **Figure Legends**

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32 373 **Figure 1**: Cluster and outlier analysis (Anselin Local Moran's) of substance use among married men in
33 374 Ethiopia, EDHS 2016. Source shape file of the map was freely available from
34 375 <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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38 376 **Figure 2**: Ordinary interpolation of substance use among married men in Ethiopia, EDHS 2016. Source
39 377 shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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42 378 **Figure 1**: Cold and hotspot analysis of substance use among married men in Ethiopia, EDHS 2016.
43 379 Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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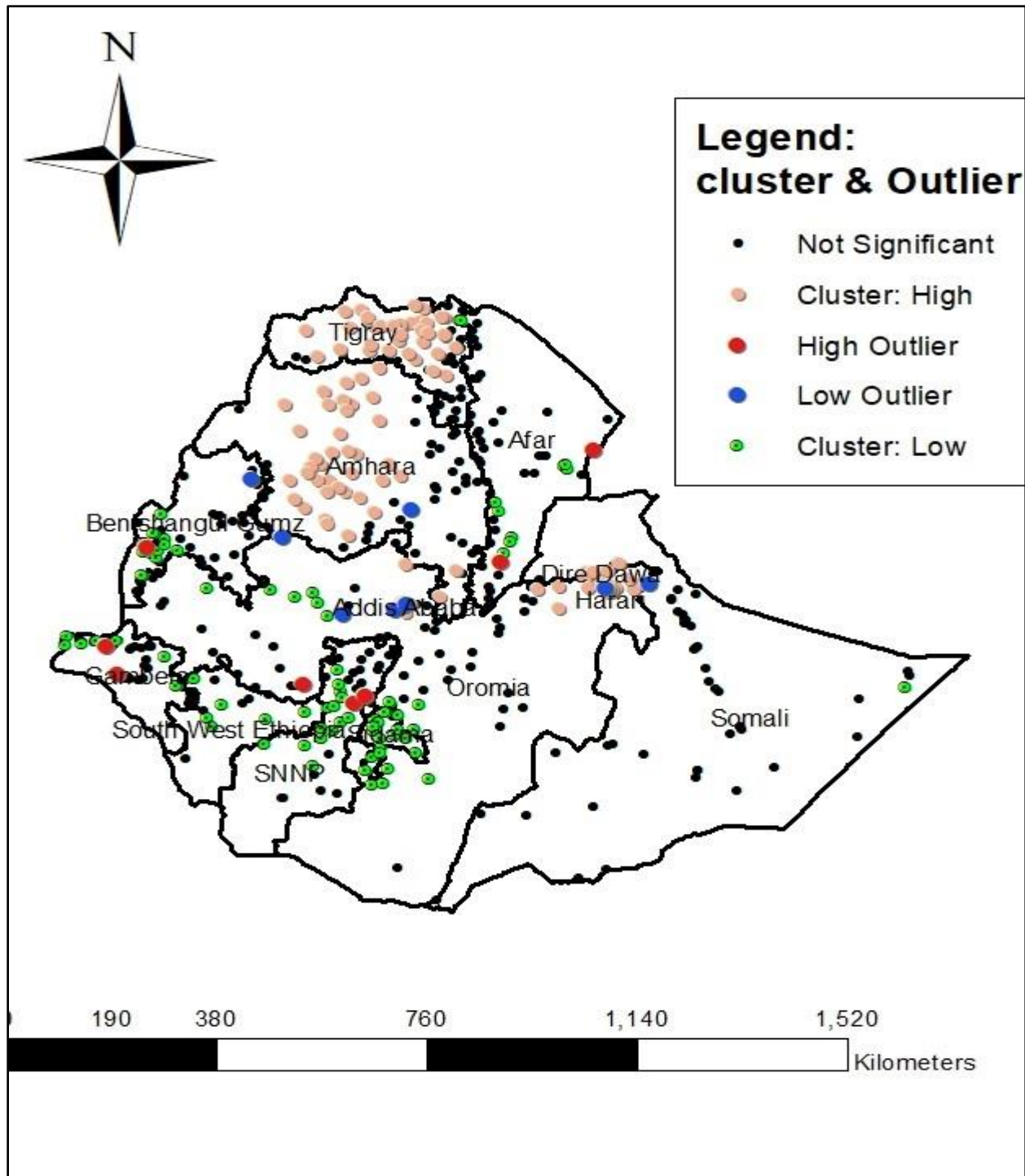


Figure 1: Cluster and outlier analysis (Anselin Local Moran's) of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africandata.org/dataset/ethiopia-shapefiles>.

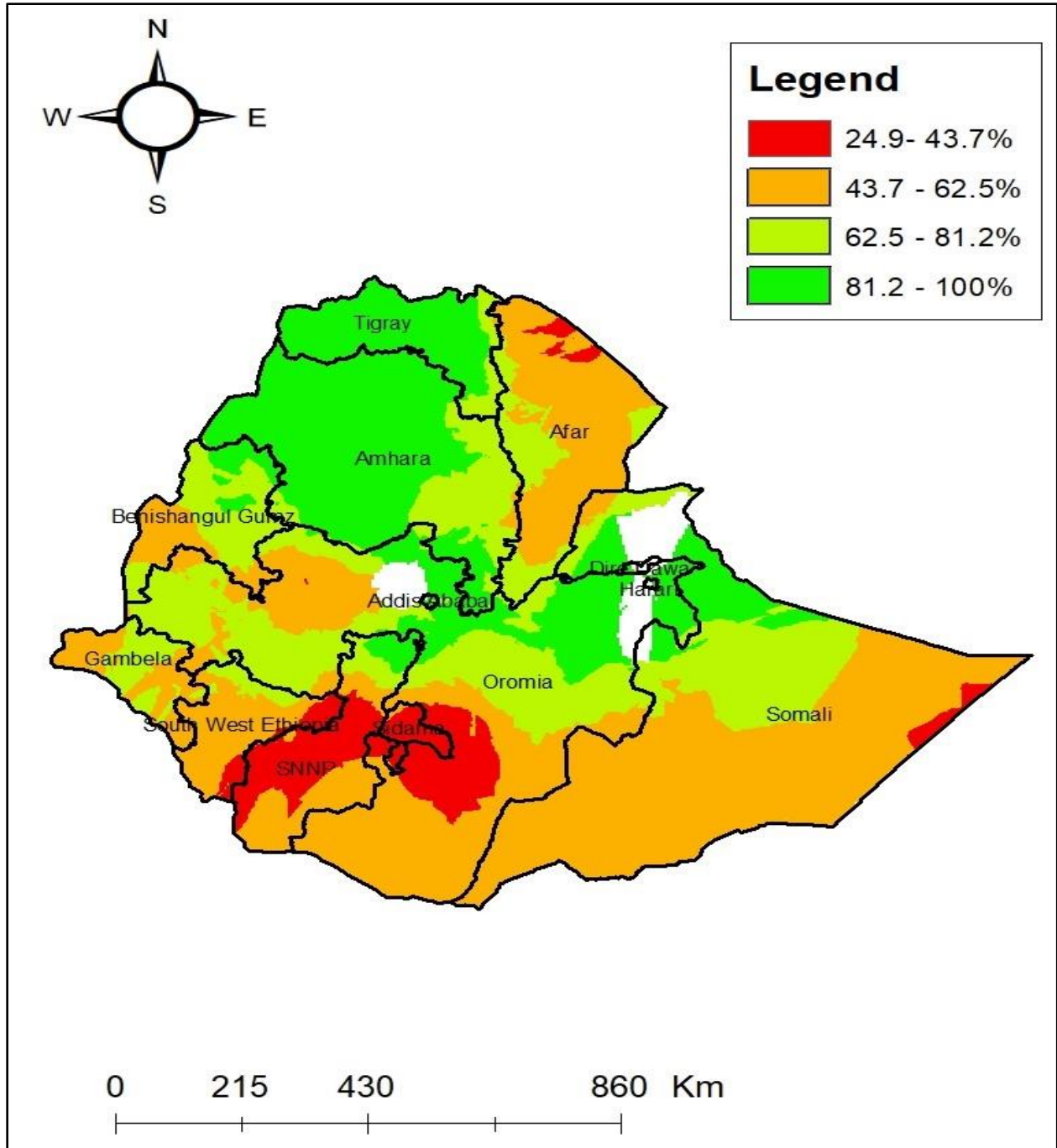


Figure 1: Predictive prevalence of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.

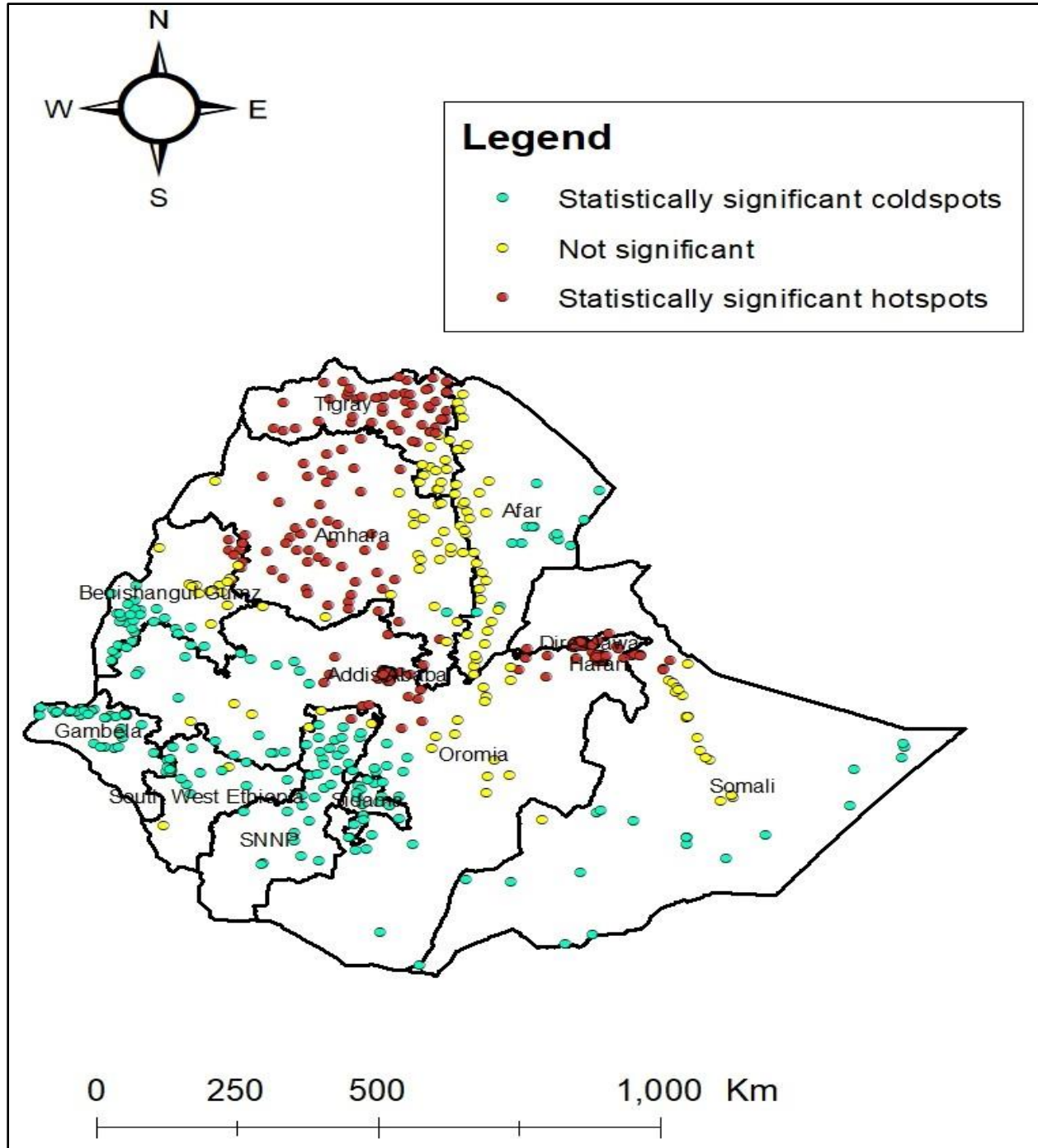
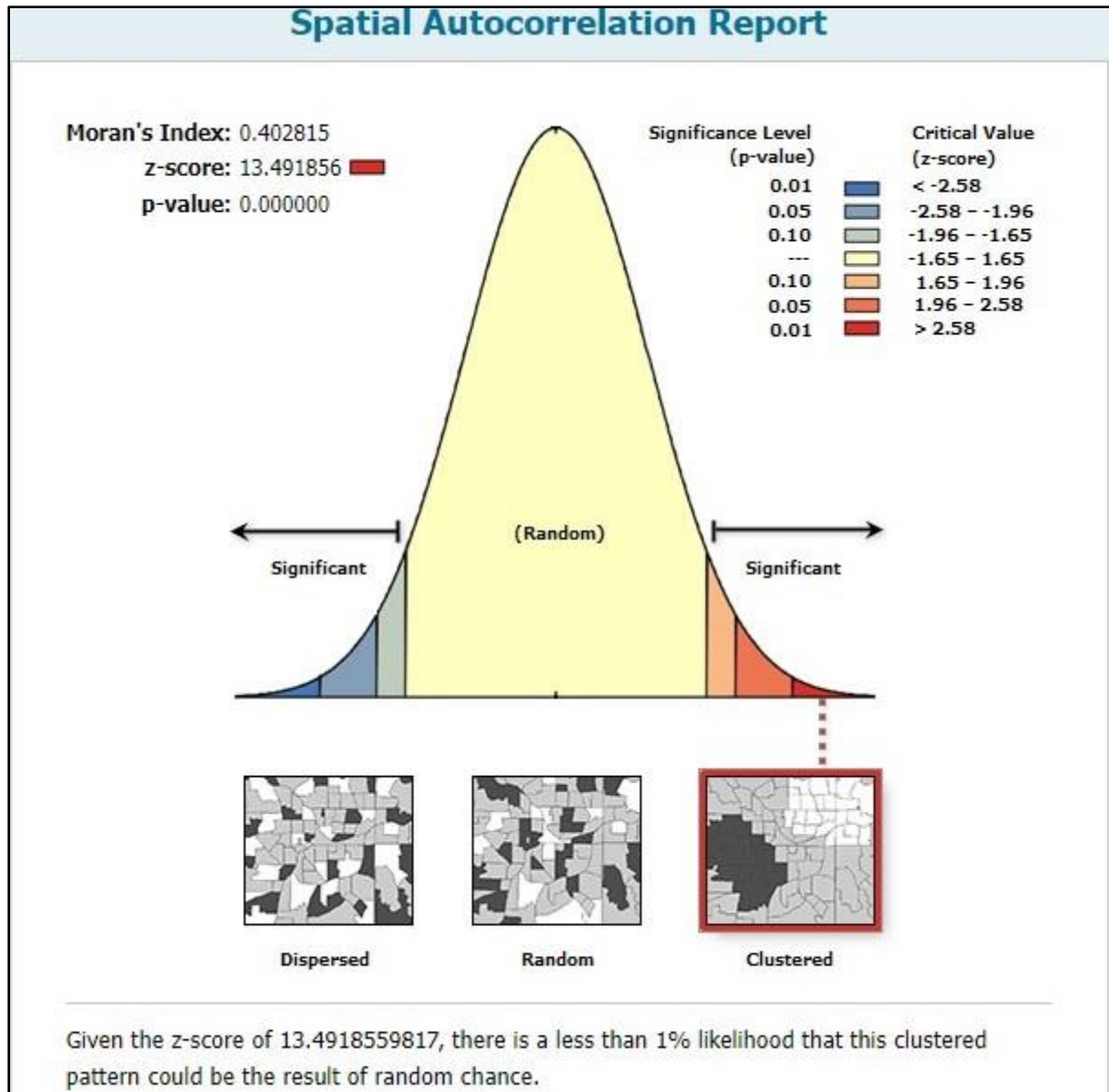


Figure 1: Cold and hotspot analysis of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.

Global Moran's I Summary	
Moran's Index:	0.402815
Expected Index:	-0.001637
Variance:	0.000899
z-score:	13.491856
p-value:	0.000000
Dataset Information	
Input Feature Class:	combineddataCopyFeatures
Input Field:	SUBSUSE__
Conceptualization:	INVERSE_DISTANCE
Distance Method:	EUCLIDEAN
Row Standardization:	True
Distance Threshold:	122473.3329 Meters
Weights Matrix File:	None

Supplementary file 1 figure: Global Moran's I Summary and dataset information of substance use among married women in Ethiopia, 2016 EDHS.



Supplementary file 2 figure: Autocorrelation report of substance use among married women in Ethiopia, 2016 EDHS.

Number of alive child with Region							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.38	0.70	0.83	1.32	
have 3-5 children	1.24	0.15	1.81	0.07	0.98	1.57	
6 and above children	1.01	0.13	0.07	0.95	0.79	1.29	
_cons	4.36	0.57	11.27	0.00	3.37	5.63	
After region is added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.04	0.12	0.34	0.74	0.82	1.32	
have 3-5 children	1.27	0.15	1.99	0.05	1.00	1.60	
6 and above children	1.06	0.13	0.46	0.65	0.83	1.36	
New_region							
Pastoralist	0.30	0.06	-6.56	0.00	0.21	0.43	
Metropolis	2.16	0.48	3.49	0.00	1.40	3.33	
_cons	5.46	0.88	10.57	0.00	3.98	7.47	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.37	0.71	0.83	1.32	
have 3-5 children	0.94	0.21	-0.26	0.79	0.61	1.46	
have 6 and above children	1.08	0.14	0.61	0.55	0.84	1.39	
New_region							
Pastoralist	0.31	0.06	-6.23	0.00	0.21	0.44	
Metropolis	2.42	0.56	3.79	0.00	1.53	3.82	
childNO1 * region 1	1.45	0.33	1.61	0.11	0.92	2.28	

childNo1 *							
region 2	1.38	0.32	1.37	0.17	0.87	2.18	
childregion3	1.00	(omitted)					
_cons	5.29	0.86	10.20	0.00	3.84	7.29	
Number of children alive and place of residence							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.40	0.69	0.83	1.33	
have 3-5 children	1.27	0.15	2.00	0.05	1.00	1.61	
have 6 and above children	1.05	0.13	0.36	0.72	0.82	1.34	
Interaction							
Residence							
rural	0.53	0.10	-3.38	0.00	0.37	0.77	
_cons	6.63	1.21	10.40	0.00	4.64	9.48	
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 childr	1.05	0.13	0.41	0.68	0.83	1.33	
have 3-5 childr	1.31	0.17	2.13	0.03	1.02	1.69	
have 6 and abc	1.06	0.14	0.44	0.66	0.82	1.36	
Residence							
rural	0.51	0.10	-3.45	0.00	0.35	0.75	
Nochil_alive * residence1	0.88	0.16	-0.74	0.46	0.62	1.24	
Nochild_alive * Residence 2	1.00	(omitted)					
_cons	6.81	1.26	10.34	0.00	4.73	9.79	

Age with community level variables						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized	1.09	0.04	2.37	0.02	1.02	1.18
_cons	3.72	0.51	9.65	0.00	2.85	4.86
Age with regions						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized						
25-34	2.11	0.49	3.21	0.00	1.34	3.33
35-44	1.77	0.24	4.27	0.00	1.36	2.31
>=45	1.58	0.22	3.3	0.00	1.20	2.07
New_region						
Pastoralist	0.31	0.06	-6.16	0	0.21	0.45
Metropolis	1.91	0.44	2.79	0.005	1.21	3.01
Products of age and region						
Agecat1 * Pastoralist	0.75	0.17	-1.27	0.20	0.48	1.17
Agecat2 * Metropolis	0.70	0.16	-1.52	0.13	0.45	1.11
Ageregio3	1	(omitted)				
_cons	3.851302	0.667324	7.78	0	2.742319	5.408755
Place of residence with age						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized						
25-34	1.58	0.23	3.11	0.00	1.18	2.10
35-44	1.68	0.25	3.54	0.00	1.26	2.25
>=45	1.51	0.23	2.74	0.01	1.12	2.03
Interaction of age with palce of residence						
Palce of residence						
rural	0.50	0.10	-3.43	0.00	0.34	0.75
agecat1 * residence1	0.74	0.25	-0.89	0.37	0.39	1.43
agecat 2 * residence2	0.83	0.14	-1.09	0.27	0.59	1.16
resiage3	1	(omitted)				
_cons	5.08	1.12	7.36	0	3.30	7.83

Educational status with region							
Variables	odds ratio	standard error	Z	P-value	95% CI		
primary education	1.13	0.10	1.42	0.157	0.95	1.33	
secondary and above	0.89	0.09	-1.06	0.29	0.73	1.10	
_cons	4.71	0.48	15.07	0	3.85	5.76	
After region added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
primary education	1.13	0.10	1.42	0.157	0.95	1.33	
secondary and above	0.89	0.09	-1.06	0.29	0.73	1.10	
_cons	4.71	0.48	15.07	0	3.85	5.76	
primary education	1.06	0.09	0.73	0.47	0.90	1.26	
secondary and above	0.80	0.09	-2.09	0.04	0.65	0.99	
New_region							
Pastoralist	0.31	0.06	-6.47	0.00	0.22	0.44	
Metropolis	2.32	0.52	3.77	0.00	1.50	3.59	
_cons	6.16	0.83	13.44	0.00	4.73	8.03	
Variables	odds ratios	standard error	Z	P-value	95% CI		
secondary and above	0.67	0.15	-1.85	0.06	0.43	1.02	
New_region							
Pastoralist	0.29	0.05	-6.62	0.00	0.20	0.42	
Metropolis	2.52	0.64	3.66	0.00	1.54	4.14	
edu1 * region1	1.08	0.28	0.31	0.76	0.65	1.81	
Edu1 * region2	1.42	0.36	1.35	0.18	0.86	2.34	
eduregio3	1.00	(omitted)					
_cons	6.28	0.86	13.43	0.00	4.80	8.22	
Educational status with place of residence							
Variables	odds ratio	standard	Z	P-value	95% CI		
primary education	1.10	0.09	1.11	0.27	0.93	1.30	
secondary and above	0.81	0.09	-1.95	0.05	0.65	1.00	
Place of residence							
rural	0.48	0.09	-3.78	0.00	0.33	0.70	
_cons	8.05	1.43	11.77	0.00	5.69	11.39	
primary education	1.10	0.09	1.13	0.26	0.93	1.30	
secondary and above	0.79	0.10	-1.82	0.07	0.60	1.02	
Educational status with place (interaction)							
Variables	odds ratio	standard error	Z	P-value	95% CI		

	Place of residence						
	rural	0.50	0.10	-3.32	0.00	0.33	0.75
	Edu1 * residence 1	1.08	0.21	0.37	0.71	0.73	1.58
	Edu1 * residence 2	1.00	(omitted)				
	_cons	7.82	1.51	10.68	0.00	5.36	11.41

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		Occupation with Region					
Variables	odds ratio	standard error	Z	P-value	95% CI		
Occupation	1	1					
Employed	1.42	0.19	2.7	0.007	1.10	1.84	
_cons	3.46	0.51	8.44	0	2.59	4.61	
After region is added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
Occupation							
Employed	1.34	0.18	2.25	0.025	1.04	1.74	
Region							
Pastoralist	0.31	0.06	-6.36	0	0.22	0.45	
Metropolis	2.17	0.48	3.52	0	1.41	3.34	
_cons	4.58	0.82	8.51	0	3.23	6.50	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
New_occup							
yes	0.53	0.20	-1.68	0.093	0.25	1.11	
New_region							
Pastoralist	0.32	0.06	-6.18	0	0.22	0.46	
Metropolis	1.96	0.44	3.04	0.002	1.27	3.04	
Employed * agrarian	0.34	0.16	-2.27	0.023	0.13	0.86	
Employed * pastoralist	0.33	0.14	-2.66	0.008	0.15	0.75	
occuregio3	1.00	(omitted)					
_cons	11.76	4.74	6.11	0	5.34	25.93	
Occupation and place of residence							
Variables	odds ratio	standard error	Z	P-value	95% CI		
occupation							
Employed	1.45	0.19	2.83	0.01	1.12	1.87	
Place of residence							
rural	0.53	0.10	-3.42	0.00	0.37	0.76	
_cons	5.26	1.02	8.57	0.00	3.60	7.70	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
occupation							

1							
2	Employed	1.73	0.28	3.35	0.00	1.26	2.38
3							
4	Place of residence						
5	rural	0.34	0.11	-3.49	0.00	0.19	0.63
6	rural * Employed	0.61	0.17	-1.80	0.07	0.36	1.05
7							
8	resioccu2	1	(omitted)				
9	_cons	6.93	1.73	7.74	0.00	4.24	11.32
10							
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Geographical variation and correlates of substance use among married men in Ethiopia: Spatial and multilevel analysis from Ethiopian Demographic and Health Survey 2016

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3 1 **Geographical variation and correlates of substance use among married men in**
4
5 2 **Ethiopia: Spatial and multilevel analysis from Ethiopian Demographic and Health**
6
7 3 **Survey 2016**
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23 Abstract

24 **Objective:** The use of substances has become one of the world's most serious public health and
25 socioeconomic issues. Most nations in Sub-Saharan Africa, including Ethiopia, are undergoing
26 significant economic transitions, creating a favorable environment for socially destructive substance
27 use. This study aimed to determine the geographical variation, prevalence, and correlates of substance
28 use among ever-married men in Ethiopia.

29 **Design:** A community-based cross-sectional survey was undertaken from January 18 to June 27, 2016.

30 **Data source:** Data was used from the 2016 Ethiopian demographic and health survey (EDHS).

31 **Data extraction and Analysis:** Data from the 2016 EDHS was used, and a total of 7793 ever-married
32 men were involved in the analysis. The spatial autocorrelation statistic (Global Moran's I) was used to
33 determine whether substance use was dispersed, clustered, or randomly distributed. A multi-level
34 logistic regression model was used to identify the correlates with substance use, and statistical
35 significance was declared at p-value < 0.05 and 95% CI.

36 **Results:** Of all ever-married men, 72.5% (95% CI 71.5, 73.4%) were currently using at least one of the
37 three substances (alcohol, cigarettes, and chat). The highest hotspot areas of substance use were
38 observed in Ahmara and Tigray regions. The age (AOR = 1.80; 95% CI: 1.32, 2.45), educational status
39 (AOR = 0.64; 95% CI: 0.51, 0.82), occupation (AOR = 1.36; 95% CI: 1.05, 1.76), watching television
40 (AOR = 1.50; 95% CI 1.25, 1.81), and living in the city (AOR = 2.25; 95% CI: 1.36, 3.74) were
41 individual and community-level correlates found to have a statistically significant association with
42 substance use.

43 **Conclusion:** In this study, nearly three-fourths of married men used one of the three substances. Given
44 these findings, it is critical to reducing the problem by improving modifiable individual-level variables
45 such as educational status and reducing substance advertising.

46 **Keywords;** Ever-married men, Substance use, EDHS, Multilevel, Ethiopia

50 **Strength and limitations of the study**

- 51 ➤ This study used a nationally representative large sample size.
- 52 ➤ The study considered the most frequently used substances like alcohol, cigarettes, and chat.
- 53 ➤ The frequency and dose of substances consumed were not considered in the study.
- 54 ➤ The clinical characteristics and the effects of addiction to these substances were not measured.
- 55 ➤ The extent of substance usage was determined through self-reported.

56 **Introduction**

57 The continued use of alcohol, tobacco, chat, caffeine, illegal narcotics, and inhalants with negative
58 consequences is referred to as substance use. Problematic substance use is defined as having a strong
59 desire to use the substance, having difficulty controlling how much or how frequently the substance is
60 used, having urges to use the substance, and continuing to use the substance despite negative
61 consequences [1, 2]. Substance abuse disorder can be caused by genes, drug action, peer pressure,
62 emotional distress, anxiety, depression, and environmental stress [3, 4].

63 Globally, there are 2 billion alcohol users, 1.3 billion smokers, and 185million drug users [5, 6].
64 Alcohol and tobacco (cigarettes) are the most commonly used substances across all age groups and
65 contribute significantly to the worldwide burden of diseases [7-10]. Most nations in Sub-Saharan Africa
66 are undergoing significant economic, social, and cultural transitions, creating a favorable environment
67 for increased and socially destructive substance use [11]. Nearly 42% of people in Sub-Saharan Africa
68 used "any substance," with the highest percentage (55.5%) in Central Africa. Males are more likely
69 than females to engage in substance use behavior [7, 12]. Substance uses among young adults is
70 associated with physical and psychosocial problems like fighting, damage, robbery, engaging in
71 unguarded sex, personal injury, medical problems, and impaired relationships with family and friends
72 [13-15].

73 Substance use has become one of the world's most serious public health problems, with devastating
74 health, socioeconomic, and environmental consequences [5]. Substance use accounts for 5.4% of the
75 global disease burden and is estimated to cost the world 28 million lost years of healthy living
76 (disability-adjusted life years) [16, 17]. Alcohol and tobacco use have also been linked to an increased
77 risk of chronic diseases such as cancer, chronic pulmonary disease, diabetes, accidents, violence,
78 cancer, and liver cirrhosis. On the other hand, Regular chat use causes gingivitis, tooth loss,

79 gastrointestinal problems, cardiac complications, male impotence, insomnia, and various mental health
80 issues [16-20].

81 Prior research conducted in Ethiopia on a small and large scale found that substance use ranged from
82 23.86 to 62.50% [21-25]. On the other hand, social mobility, accessibility, low wealth, low level of
83 education, lower socioeconomic groupings, increasing age, employment, and stressful life events were
84 factors of substance use (chat, cigarettes, and alcohol). Other motivations for substance use have been
85 discovered, such as improved well-being, excitement, social participation, increased alertness, stress
86 reduction, increased capacity to focus, and addiction [22-28].

87 Substance abuse endangers people's health and their social and economic well-being [5, 29, 30].
88 Ethiopia's government implemented a mandatory policy to counteract these dangers and raised taxes on
89 regularly used substances. Alcohol advertising is now forbidden in Ethiopia, according to proclamation
90 No. 759/2012, when the alcohol content exceeds 12% [31]. Even though we have a proclamation to
91 manage substance use, there is still significant difficulty with its execution and limited evidence about
92 the extent of substance use and its correlates. To the best of our knowledge, there is no study on
93 substance usage among Ethiopian ever-married men. Thus, this study was designed to determine the
94 geographical variation, prevalence, and correlates of substance use among ever-married men in
95 Ethiopia using the 2016 EDHS.

96 **Methods**

97 **Study setting and design**

98 Ethiopia is Africa's second-most populated country, with 117.7 million people, and is divided into three
99 metropolitan (city) and nine non-metropolitan regions [32, 33]. According to the 2016 EDHS report,
100 roughly 61.4 % of the men in the study have ever-married. A community-based cross-sectional survey
101 was undertaken from January 18 to June 27, 2016 [33].

102 **Data source and population**

103 This study used data from the 2016 EDHS, specifically the male dataset.

104 **Sample size and sampling methods**

105 The entire demographic and health survey sample was designed to represent all of the country's regions
106 and administrative cities. In the Ethiopian health and demographic survey (2016), two-phase sample
107 procedures were used, with clusters picked in the first phase and households selected in the second
108 [34]. Every region was divided into two strata: urban and rural. The sample size was then allocated

109 using a probability proportional allocation method. The survey included around 645 clusters, with 200
110 from the urban and 443 from the rural. As a result, the study included a total of 7793 ever-married men,
111 with 1,262 from the urban and 6,531 from the rural.

112 **Data collection tool and quality assurance**

113 The fundamental three data collection tools for the DHS were adopted from the demography and health
114 survey project. These data collection tools include questions for the household, women, and men [33].
115 The data for this study came from the men's questionnaire. The data questionnaire was written in
116 English and then translated into the three main local languages: Amharic, Afan Oromo, and Tigrigna. A
117 pretest was conducted before data collection, and all data collectors, supervisors, and quality controllers
118 who participated in the surveys received training.

119 **Operational definition**

120 **An ever-married man;** is a man who has been married at least once in their life or on the data
121 collection date.

122 **Substance use** is defined as a self-report of exposure to at least one of the three substances (alcohol,
123 chat, tobacco) before the interview, irrespective of its dose and frequency (yes/no) [35].

124 **Study variable and measurements**

125 **Outcome variable**

126 Substance use is the outcome variable with two categories (yes = 1 when a substance is used and no = 0
127 if no substance is used). Substance use was determined to depend on the ever-married men's self-report
128 using a single item for each substance. 'Do you currently smoke or use any other type of tobacco every
129 day, some days, or not at all?' As a result, anyone who reported every day or some days was taken as a
130 current smoker. Chat chewing and alcohol use behaviors were also determined using: 'During the last
131 30 days, how many days did you chew chat?' and 'During the last 30 days, how many days did you
132 have a drink that contains alcohol?' In both issues, anybody who described at least one day of use in the
133 former 30 days was taken as current chat and alcohol users, respectively [33]. The prevalence of
134 substance use was calculated by dividing the total number of substance users (obtained from a
135 composite score of three substances) by the total number of ever-married men from the 2016 EDHS.

136 **Independent variables**

137 The individual and community-level independent variables were included. **Individual-level variables**
138 involve men's current age (15-24, 25-34, 35-44, >=45 years), educational status (no formal education,
139 primary, secondary, and above), religion (Christian, Muslim, and others), occupation (employed, not

1
2
3 140 employed), a number of living children (0, 1-2, 3-5, >=6), wealth index (poor, middle and rich), land
4
5 141 ownership (yes, no), housing ownership (yes, no), wife refusing sexual intercourse/sexual
6
7 142 incompatibility (yes, no), had any STI (yes, no), ever tested for HIV (yes, no), frequently watching
8
9 143 television (not at all, at least once a week), have a bank account (yes, no). **Community-level variables**
10
11 144 include place of residence (urban, rural) and regions recoded into agrarian, pastoralist, and metropolises
12
13 145 (city). The agrarian region is obtained by re-coding the Tigray, Amhara, Oromia, and South Nation
14
15 146 Nationality People's Republic regions (SNNPR); the pastoralist region involves Afar, Somali,
16
17 147 Benishangul, and Gambella regions. The metropolises (city) administration regions include Harari,
18
19 148 Addis Ababa, and Dire Dawa. Residents' living stability and social change index were used to combine
20
21 149 these regions. The regions considered a city (metropolis) have a greater social change index than other
22
23 150 regions. The pastoral regions originated in the lowland areas of Ethiopia, mostly traveling from place to
24
25 151 place with their cattle to find grass and water. The agrarian regions originated in the highland area of
26
27 152 the country, in which agriculture is the principal work.

26 153 **Data extraction and analysis**

28 154 STATA software version 14 was used to analyze the data. The weighted samples were employed in
29
30 155 data analysis to ensure that the survey results represented national and regional findings. In order to
31
32 156 ensure the survey's representativeness by region and account for non-response, data were weighted
33
34 157 using the men's data weighting variable (mv005/10⁶) as recommended by the DHS. Using STATA 'svy'
35
36 158 function, the analysis was also employed to describe the complex survey design and resilient standard
37
38 159 errors (stratification and clustering). Tables and graphs were used to generate and organize descriptive
39
40 160 statistics such as frequency and percentage. Individual and community-level variable frequencies were
41
42 161 calculated in relation to the outcome variable. The correlates of substance use were identified using a
43
44 162 multi-level logistic regression model. At the same time, four models were fitted to estimate the fixed
45
46 163 influence of individual and community level correlates and the random effect of cluster fluctuations.
47
48 164 First, the null model was run without any correlates. The effect of individual-level correlates on
49
50 165 substance use was estimated using the second model. The third model was used to examine the effect of
51
52 166 community-level correlates with substance use. Finally, the fourth model was run to estimate the
53
54 167 combined effects of individual and community level correlates. The proportional change in variance
55
56 168 (PCV) was computed using the community-level variance in the null model as the denominator, which
57
58 169 is the proportion of total community-level variance explained by individual and community-level
59
60 170 variables. The Intra-Cluster Correlation (ICC) was determined to indicate random effects within a

1
2
3 171 model [36, 37]. Akaike's Information Criterion (AIC) and Bayesian information criteria (BIC) were
4
5 172 used for model selection. Each value of AIC and BIC in all models with the lowest value was
6
7 173 considered [38, 39]. The median odds ratio (MOR) was calculated to indicate mysterious cluster
8
9 174 heterogeneity [36]. Variables having *P*-value up to 0.25 in the bivariable logistic regression analysis
10
11 175 were considered to fit multivariable logistic regression analysis. Variance inflation factor was used to
12
13 176 notice multicollinearity within individual-level correlates. The fixed effects of individual and
14
15 177 community level correlates on substance use were stated using an adjusted odds ratio (AOR) with 95%
16
17 178 confidence intervals (CI). Accordingly, the final model (4th model) was used to designate the combined
18
19 179 effect of individual and community-level correlates on substance use among ever-married men. A *P*-
20
21 180 value < 0.05 and an adjusted odds ratio with 95% confidence intervals were considered to declare
22
23 181 statistical significance. The moderation analysis was performed to determine whether community-level
24
25 182 variables moderated individual-level variables.

25 183 **Spatial autocorrelation analysis**

26
27 184 In this study, the spatial statistics tool used to perform the spatial analysis was ArcGIS Version 10.3;
28
29 185 Redlands, California, United States. The spatial autocorrelation statistic (Global Moran's I) was used to
30
31 186 determine whether substance use was dispersed, clustered, or randomly distributed. The cluster and
32
33 187 outlier analyses were used to examine the spatial heterogeneity of substance use in enumeration areas
34
35 188 as high and low. The cold and hotspot areas of substance use were indicated using the Getis-Ord G_i^*
36
37 189 statistics and related *Z*-scores. Furthermore, the spatial interpolation analysis, which employs the
38
39 190 Kriging ordinary interpolation, was used to forecast the prevalence of substance use for not sampled or
40
41 191 unmeasured values from sampled measurements.

41 192 **Patient and public involvement**

42 193 None.
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199 **Results**200 **Socio-demographic characteristics of ever-married men**

201 The analysis included a total of 7793 ever-married men from the 2016 demographic and health survey.
 202 The men's mean age (standard deviation) was 37.3 (± 9.7), and 42% of ever-married men had never
 203 attended formal education. The Oromia region had about 38% of ever-married men, and 83.8% of them
 204 lived in rural areas. Most men who had ever married had three to five living children, and 96.1% of
 205 ever-married men were actively employed. (Table 1)

206 **Table 1: Socio-demographic characteristics of ever-married men in Ethiopia using 2016 DHS**
 207 **(n= 7,793)**

Variables	Weighted frequency	%
Age of the respondents		
15-24	566	7.3
25-34	2745	35
35-44	2484	32
≥ 45	1998	25
Educational status		
No formal education	3284	42
Primary education	3179	40
Secondary and above education	1329	17
Religion		
Christian	5076	65
Muslim	2610	34
Others*	106	1
Occupation		
Employed	7492	96.1
Not employed	300	3.9
Number of living children		
No children	827	10.6
One to two children	2247	28.8
Three to five children	2771	35.6
Six and above	1948	25.0
Wealth index		
Poorest	1366	17.5
Poorer	1617	20.8
Middle	1550	19.9
Richer	1584	20.3
Richest	1674	21.5
Place of residence		

8

Urban	1262	16.2
Rural	6530	83.8
Region		
Harari	19	0.25
Gambella	21	0.3
Dire Dawa	41	0.5
Afar	59	0.8
Benishangul Gumuz	84	1.1
Somali	208	2.7
Addis Ababa	278	3.6
Tigray	461	5.9
SNNPR	1570	20.1
Amhara	2090	26.8
Oromia	2961	38.0

*traditional religion, “wakefata”

The prevalence of substance use

In this study, one of the three substances, alcohol, cigarette, and chat, was used by 72.5% (95% CI 71.5, 73.4%) of the ever-married men. About 59.6%, 11.8%, and 1.1% of ever-married men used one, two, and all three substances, respectively. Alcohol (48.4%) and chat (31.9%) were the most commonly used substance by ever-married men. Almost two-thirds (73%) of ever-married men aged 25-34 years were using one of the three substances. Married men with no formal education were found to use one of the three substances at a higher rate (78.3%). In contrast, 72.8% of employed married men used one of the three substances. Besides, married men living in rural and agrarian regions used one of the three substances at a similar rate (72%). (Table 2)

Spatial distribution of substance use in Ethiopia

The spatial autocorrelation analysis revealed that Ethiopia's spatial distribution of substance use was clustered. The Global Moran's I value of 0.403 (p-value < 0.001) indicated that substance use was significantly clustered in Ethiopia (Supplementary file figures 1 and 2). Clusters with a high proportion of substance use were from Tigray and Amhara regions, whereas clusters with a low proportion of substance use were observed in Sidama (North, West, and East) and Oromia (Southwest), Addis Ababa, Gambella, and Benishangul Gumuz (Fig 1).

In this study, ordinary kriging interpolation analysis was used to predict the prevalence of substance use. Accordingly, high levels of substance use were observed in Amhara, Oromia, Addis Ababa, and

227 Somali regions. On the other hand, the low substance use areas were predicted in the SNNP, Sidama,
228 and Somali regions (Fig 2).

229 **Hotspot detection of substance use**

230 The highest proportions of substance use among ever-married men were reported from Tigray and
231 Ahmara regions. Similarly, the highest hotspot areas of substance use were observed in Tigray,
232 Ahmara, Addis Ababa, Harari, and Dire Dawa regions. On the other hand, the cold spot area of
233 substance use was seen in Benishangul Gumuz, Gambella, SNNPR, Sidama, and southwest people of
234 Ethiopia regions (Fig 3).

235 **Correlates of substance use**

236 We have conducted a multilevel logistic regression analysis using the 2016 EDHS to identify the
237 individual and community-level correlates with substance use. The interclass-correlation in the empty
238 model showed 52.2% variability in the prevalence of substance use among ever-married men
239 recognized to the difference between clusters in the community. Additionally, the variability among
240 clusters in Model II was 50.1%, 48.1% in Model III, and 47.2% in Model IV. The proportion of change
241 in the variance was 41.8% for Model II (individual-level correlates), 45.4% for Model III (community-
242 level correlates), and 56.8% for Model IV (combined individual-and community-level correlates), in
243 which addition of the correlates to empty model well explained within three models, particularly in the
244 final model. In moderation analysis, only the occupation of respondents was significantly moderated by
245 region (Supplementary file 3-6 tables).

246 **Individual level correlates:** The odds of substance use were 59 and 80% higher among ever-married
247 men who were in the age category of 25-34 (AOR = 1.59; 95% CI: 1.21, 2.10) and 35-44 (AOR = 1.80;
248 95% CI: 1.32, 2.45) in relation to men within the age category of 15-24 years old. The ever-married
249 men who had attended secondary and above education were 36% less likely to use substances than men
250 who had no formal education (AOR = 0.64; 95% CI: 0.51, 0.82). The odds of substance use were 34%
251 higher among ever-married men with 3 to 5 living children compared to their counterparts (AOR =
252 1.34; 95% CI: 1.04, 1.53). The odds of substance use among employed ever-married men were 36%
253 higher than in unemployed men (AOR = 1.36; 95% CI: 1.05, 1.76). The odds of substance use were
254 76% higher among ever-married men who had a sexual incompatibility with their wives compared to
255 their counterparts (AOR = 1.76; 95% CI 1.43, 2.86). On the other hand, ever-married men who had

ever tested for HIV were obtained to have 43% higher odds of substance use than their counterparts (AOR = 1.43; 95% CI 1.22, 1.68). Similarly, the ever-married men who watched television at least once a week had 50% higher odds of substance use than their counterparts (AOR = 1.50; 95% CI 1.25, 1.81).

Community-level correlates: The odds of substance use among ever-married men living in the metropolises (city) regions were 2.25 times more likely than those living in the agrarian regions (AOR = 2.25; 95% CI: 1.36, 3.74). Besides, there were 65% lower odds of substance use among ever-married men living in the pastoralist region compared to those living in the agrarian regions (AOR = 0.35; 95% CI: 0.24, 0.51). (Table 2 and 3)

Table 2: Multilevel bivariable logistic regression analysis of substance use among married men in Ethiopia using the 2016 EDHS (n = 7793)

Variables	Substance use		COR 95% CI	P-value
	Yes, n (%)	No n (%)		
Age of the respondents				
15-24	383(67.7)	183(32.3)	1	
25-34	1998(72.8)	748(27.2)	1.62(1.25, 2.10)	< 0.001
35-44	1818(73.2)	666(26.8)	1.81(1.39, 2.35)	< 0.001
>=45	1447(72.4)	551(27.6)	1.61(1.23, 2.12)	0.001
Educational status				
No formal education	2571(78.3)	713(21.7)	1	
Primary education	2186(68.8)	994(31.2)	1.13(0.96, 1.33)	0.157
Secondary and above education	889(66.9)	440(33.1)	0.89(0.73, 1.10)	0.290
Religion				
Christian	3548(69.9)	1528(30.1)	1.12(0.91, 1.38)	0.290
Muslim	2043(78.3)	568(21.8)	1.26(1.04, 1.54)	0.020
Others	55(51.8)	51(48.2)	1	
Occupation				
Employed	5454(72.8)	2039(27.2)	1.42(1.10, 1.84)	0.007
Not Employed	192(64)	108(36)	1	
Number of living children				
No children	671(81.1)	157(18.9)	0.99(0.77, 1.27)	0.947
One to two children	1607(71.5)	640(28.5)	1.04(0.86, 1.25)	0.696
Three to five children	2038(73.5)	734(26.5)	1.23(1.03, 1.47)	0.021
Six and above	1331(68.3)	617(31.7)	1	
Wife refusing sexual intercourse				
Yes	738(75.5)	240(24.5)	1.64(1.10, 2.04)	< 0.001
No	4909(72)	1907(28)	1	

Have any STI				
Yes	125(71.0)	51(29)	0.88(0.50, 1.57)	0.086
No	5520(72.5)	2096(27.5)	1	
Ever tested for HIV				
Yes	3111(75.5)	1007(24.5)	1.47(1.26, 1.70)	< 0.001
No	2535(69)	1140(31)	1	
Frequently watching television				
Not at all	2906(67.6)	1395(32.4)	1	
At least once a week	2741(78.5)	752(21.5)	1.59(1.34, 1.88)	< 0.001
Have a bank account				
Yes	1783(78)	504(22)	1.29(1.10, 1.55)	0.004
No	3863(70.2)	1643(29.8)	1	
Wealth index				
Poor	2207(74)	778(26)	1	
Middle	1128(72.7)	423(27.3)	0.96(0.77, 1.19)	0.694
Rich	2312(70.9)	947(29.1)	1.20(0.98, 1.46)	0.073
Place of residence				
Urban	946(74.9)	317(25.1)	1	
Rural	4700(72)	1830(28)	0.54(0.38, 0.78)	0.001
Region				
Agrarian	5117(72.2)	1966(27.8)	1	
Pastoralist	235(63.2)	137(36.8)	0.30(0.21, 0.43)	< 0.001
Metropolises	294(87)	44(13)	2.12(1.38, 3.26)	0.001

268 *HIV-Human immunodeficiency virus; STI-Sexually transmitted infection*

269 **Table 3: Multilevel multivariable logistic regression analysis of substance use among ever-**
 270 **married men by individual and community level correlates from 2016 EDHS data (n = 7793)**

Variables	Model I (null model)	Model II	Model III	Model IV
		Individual-level variables	Community-level variables	Individual and community-level variables
Age of the respondents				
15-24		1		1
25-34		1.63(1.24, 2.15)**		1.59(1.21, 2.10)**
35-44		1.89(1.38, 2.57)**		1.80(1.32, 2.45)**
>=45		1.84(1.32, 2.57)**		1.71(1.22, 2.39)
Educational status				
No formal education		1		1
Primary education		0.99(0.83, 1.18)		0.98(0.82, 1.17)
Secondary and above education		0.65(0.51, 0.83)**		0.64(0.51, 0.82)**
Religion				
Christian		1		1
Muslim		0.92(0.74, 1.15)		1.02(0.82, 1.29)

Others		1.50(0.80, 2.82)		1.50(0.80, 2.82)
Occupation				
Employed		1.42(1.10, 1.84)*		1.36(1.05, 1.76)*
Not employed		1		1
Number of living children				
No children		1.54(0.78, 2.85)		1.25(0.90, 1.74)
One to two children		1.35(0.57, 2.56)		1.14(0.86, 1.39)
Three to five children		1.59(1.34, 2.78)*		1.34(1.04, 1.53)*
Six and above		1		1
Wife refusing sexual intercourse				
Yes		1.85(1.49, 2.91)*		1.76(1.43, 2.86)*
No		1		1
Have any STI				
Yes		0.86(0.48, 1.54)		0.83(0.46, 1.47)
No		1		1
Ever tested for HIV				
Yes		1.44(1.23, 1.70)**		1.43(1.22, 1.68)**
No		1		1
Frequently watching television				
Not at all		1		1
At least once a week		1.57(1.31, 1.89)**		1.50(1.25, 1.81)**
Have a bank account				
Yes		1.15(0.94, 1.40)		1.12(0.93, 1.37)
No		1		1
Wealth index				
Poor		1		1
Middle		0.92(0.73, 1.15)		0.84(0.68, 1.10)
Rich		1.03(0.83, 1.28)		0.89(0.71, 1.11)
Place of residence				
Urban			1	1
Rural			0.93(0.62, 1.40)	1.10(0.70, 1.70)
Region				
Agrarian			1	
Pastoralist			0.30(0.21, 0.43)**	0.35(0.24, 0.51)**
Metropolises			2.02(1.22, 3.35)*	2.25(1.36, 3.74)*
Measure of variation				
Community level variance (Se)	3.61(0.084)**	3.31(0.083)**	1.97 (0.078)**	1.56(0.079)**
ICC % (95% CI)	52.2(47.9, 56.6)	50.1(45.7, 54.6)	48.1(43.6, 52.5)	47.2(42.7, 51.7)
PCV (%)	Reference	41.8	45.4	56.8
MOR	3.44	2.00	1.88	1.49

Model selection				
Log-likelihood	-3501.14	-3440.65	-3459.51	-3416.06
AIC	7006.27	6925.31	6929.03	6878.11
BIC	7020.14	7077.85	6963.70	7037.56

271 *AIC- Akaike's Information Criterion, BIC- Bayesian Information Criterion, ICC- Intra-Cluster Correlation,*
 272 *PCV -Proportional Change in Variance, SE Standard Error, MOR, median odds ratio; AOR-Adjusted Odds*
 273 *Ratio; *p-value< 0.05, **p-value < 0.001*

274 **Discussion**

276 This study was done to investigate the prevalence and correlates of substance use among ever-married
 277 men in Ethiopia using the 2016 EDHS. In this study, the overall one of the three substance use was
 278 72.5%, with 59.6 % using only one substance. This study's finding was slightly higher than those
 279 studies conducted in Ethiopia [25] and sub-Saharan Africa [7]. This might be due to the difference in
 280 the age of participants, duration of the study, and sample size. Around 12.9% of the respondents were
 281 two and above substance users, which is lower than a previous study conducted in Ethiopia [40] and
 282 studies conducted in the USA [41], Scotland [42], and United Arab Emirates [43]. The discrepancy in
 283 the prevalence of substance use can be explained by the characteristics of the respondents, socio-
 284 economic status, accessibility of the substances, and social desirability bias. Cigarettes (7.4%), chat
 285 (31.6%), and alcohol (47.8 %) were the most often utilized substances in ascending order. In terms of
 286 chat use, the results were lower than the findings in prior studies conducted in Ethiopia [44-46], Yemen
 287 [47], and Uganda [48]. This wide range of results could be attributable to differences in sample size,
 288 study duration, and study participant characteristics.

289 On the other hand, the DHS was conducted among a large population and described as an
 290 amalgamation of the country's most remote and urbanized locations. Alcohol was one of the most
 291 commonly utilized substances in this survey. This finding was in line with research conducted in
 292 Ethiopia [23, 49], but it was at odds with findings from Morocco [50], Bangladesh [51], and the United
 293 States [52], where the cigarette was widely used. The variation could be due to the method employed to
 294 measure alcohol use and media advertising, as well as socioeconomic differences. In Ethiopia, there is a
 295 wide difference in substance use by region. The Amhara and Tigray regions had a greater percentage of
 296 substance users (92% vs. 95%, respectively), consistent with earlier findings in Ethiopia [25, 53].

297 On the other hand, the spatial autocorrelation analysis of at least one of the three substance use across
 298 the regions was observed as a clustering pattern (Global Moran's I = 0.403, p-value< 0.0001). This

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3 299 indicates that one of the three substances used in Ethiopia was aggregated in specific areas.
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5 300 Accordingly, the highest hot-spot areas were found in Tigray (central and west), Amhara (central and
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7 301 east), Addis Ababa (central), Harari (west), Dire Dawa (west), and some parts of the northwest
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9 302 Benishangul Gumuz region. Differences in substance usage by geographic region could be attributable
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11 303 to socioeconomic level, culture, and accessibility of substances.

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13 304 Individual and community-level correlates such as current age of ever-married men, attending
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15 305 secondary and higher education, being employed, the number of living children, sexual incompatibility
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17 306 with their wife, ever tested for HIV, frequently watching television, living in metropolises (city), and
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19 307 pastoralist region was found to have a statically significant correlates based on the multilevel logistic
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21 308 regression analysis. Compared to men between the ages of 15 to 24, the odds of substance use were
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23 309 higher among ever-married men between the ages of 25 to 34. This finding was in line with a previous
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25 310 study conducted in Ethiopia [25, 44, 53, 54]. This could be because the likelihood of substance abuse
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27 311 rises as people live longer and have more life experiences [55, 56]. Secondly, young individuals may be
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29 312 reliant on their families, which lessen the pre-arranged condition for using substances, such as the
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31 313 ability to purchase them. Ever-married men with a secondary or higher education had a lower risk of
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33 314 substance use when compared to men who had no formal education. This finding is comparable to a
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35 315 study in Saudi Arabia [57]. The possible explanation for this finding might be that illiterate men would
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37 316 have a lack of information on the negative consequences of substance use on their health. The
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39 317 probabilities of substance use were higher among employed ever-married males than among jobless
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41 318 men, which is consistent with prior Ethiopian study findings [28, 44]. This may be related to the fact
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43 319 that unemployed people can't afford to buy substances. In the moderation analysis, the occupation was
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45 320 significantly moderated by the community level correlate, which is the region. The extent of association
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47 321 between occupation and substance use was increased due to community level moderator (region).
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49 322 When compared to their counterparts, the odds of substance use were higher among ever-married men
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51 323 who had a sexual incompatibility with their wives. This could be explained by the fact that when there
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53 324 is a sexual incompatibility between two partners, there is a chance that men will use substances to cope
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55 325 with the stress.

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58 326 Similarly, ever-married males who watched television (TV) at least once a week had a higher risk of
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60 327 substance use than those who did not watch TV at all. This result was in line with a previous study
328 conducted elsewhere.²⁵ This could be because some substances, such as alcohol, are heavily promoted

329 in the media (television). Substance use was more common among ever-married men who lived in
330 metropolises (city) regions than those who lived in agrarian regions. Furthermore, ever-married men
331 living in the pastoralist zone had lower odds of substance use than those living in the agrarian regions.
332 This finding was in line with earlier Ethiopian research [44, 58]. Disparities in substance usage by
333 geographical region may be attributable to differences in substance distribution, accessibility,
334 production, marketing, and other cultural elements of Ethiopian men [59, 60].

335 Despite using a sizable, nationally representative sample, the study has some limitations related to
336 respondents and secondary data. Firstly, as the study is cross-sectional, it is impossible to conclude a
337 causal relationship between the determinants and the outcome variables. Secondly, the study did not
338 consider the frequency, dosage, clinical characteristics and effects of addiction to these substances.
339 Thirdly, the outcome variable was established by asking questions that might have influenced the level
340 of substance use rather than validating blood samples. Besides, substance use could be rejected as the
341 substance use response was based on self-reporting. Thus, our study did not look at all substances;
342 instead, it concentrated on alcohol, cigarettes, and Chat.

343 **Conclusion**

344 Despite the aforementioned limitations, nearly three-fourths of ever-married men used one of the three
345 substances. Alcohol was by far the most often used substance. There was a disparity in the prevalence
346 of substance use by geographic region, with Amhara and Tigray having the highest percentages.
347 Individual and community-level correlates such as current age, secondary and higher education,
348 employment, number of living children, HIV testing history, sexual incompatibility with their wife,
349 frequent television watching; living in metropolises(city), and pastoralist regions were found to have a
350 statistically significant relationship with one of the tree substance use. Given these findings, it is critical
351 to lessen the problem by improving modifiable individual-level variables such as educational status,
352 reducing sexual incompatibility with their wife, and reducing substance advertising through mass
353 media.

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4

5
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7

8 360 None declared.
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11 361 **Patient consent for publication**
12

13 362 Not applicable.
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16 363 **Ethical considerations and data set access**
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18 364 Demographic and Health Surveys in Ethiopia were done after obtaining ethical clearance from Ethiopia
19 365 Health and Nutrition Research Institute Review Board, the Ministry of Science and Technology, the
20 366 Institutional Review Board of ICF International, and the CDC [28]. The entire procedure of the survey,
21 367 with the organization of actions, questionnaire design, data collectors training, supervisors, and all
22 368 people involved in the procedure and report writing, were strictly followed. Data were collected after
23 369 taking informed consent, and all information was kept confidential. For these detailed research
24 370 activities, consent was given by the Demographic and Health Surveys Program project to access 2016
25 371 EDHS data after evaluation of the submitted summary of the planned study. All the ethical concerns,
26 372 including informed consent, anonymous are followed [28].
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30 373 **Availability of data and materials**
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33 374 The manuscript contains all of the important findings, and all data used for the statistical analysis is
34 375 publicly available (www.dhsprogram.com). "Because we used 2016 EDHS data, we are not authorized
35 376 to share the data with a third party." Furthermore, the 'Dataset Terms of Use' prohibit us from
36 377 distributing this data following data access rules (<http://dhs.gov>).
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43 378 **Supplementary Files**

44 379 *Supplementary file 1 figure*: Global Moran's I Summary and dataset information of substance use
45 380 among married women in Ethiopia, 2016 EDHS.

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47 381 *Supplementary file 2 figure*: Autocorrelation report of substance use among married women in
48 382 Ethiopia, 2016 EDHS.

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50 383 *Supplementary file 3-6 Tables*: Moderator Analysis (PDF)

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52 384 **Figure Legends**
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3 385 **Figure 1:** Cluster and outlier analysis (Anselin Local Moran's) of substance use among married men in
4 386 Ethiopia, EDHS 2016. Source shape file of the map was freely available from
5 387 <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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9 388 **Figure 2:** Ordinary interpolation of substance use among married men in Ethiopia, EDHS 2016. Source
10 389 shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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13 390 **Figure 1:** Cold and hotspot analysis of substance use among married men in Ethiopia, EDHS 2016.
14 391 Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.
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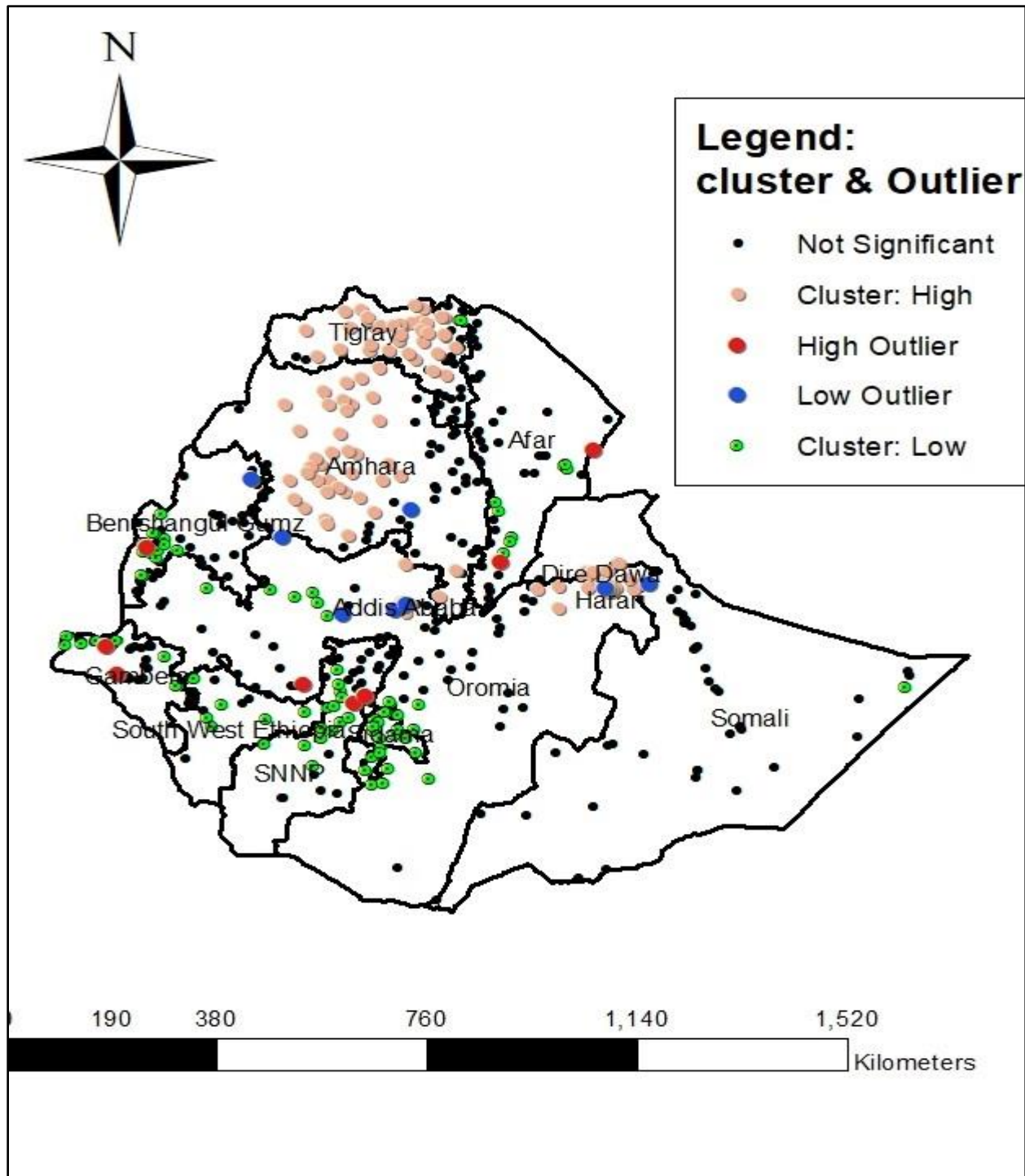


Figure 1: Cluster and outlier analysis (Anselin Local Moran's) of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africandata.org/dataset/ethiopia-shapefiles>.

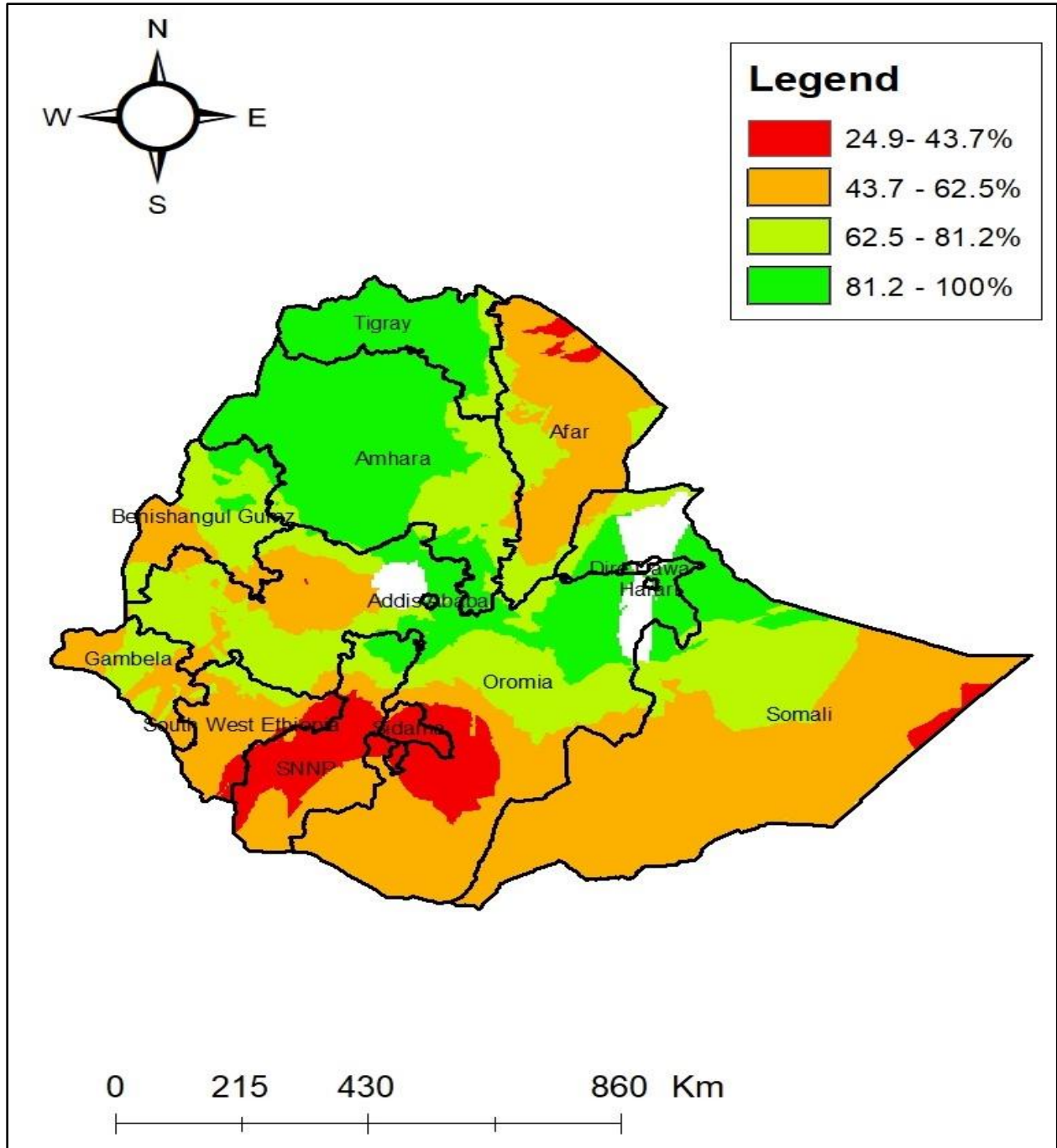


Figure 2: Predictive prevalence of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.

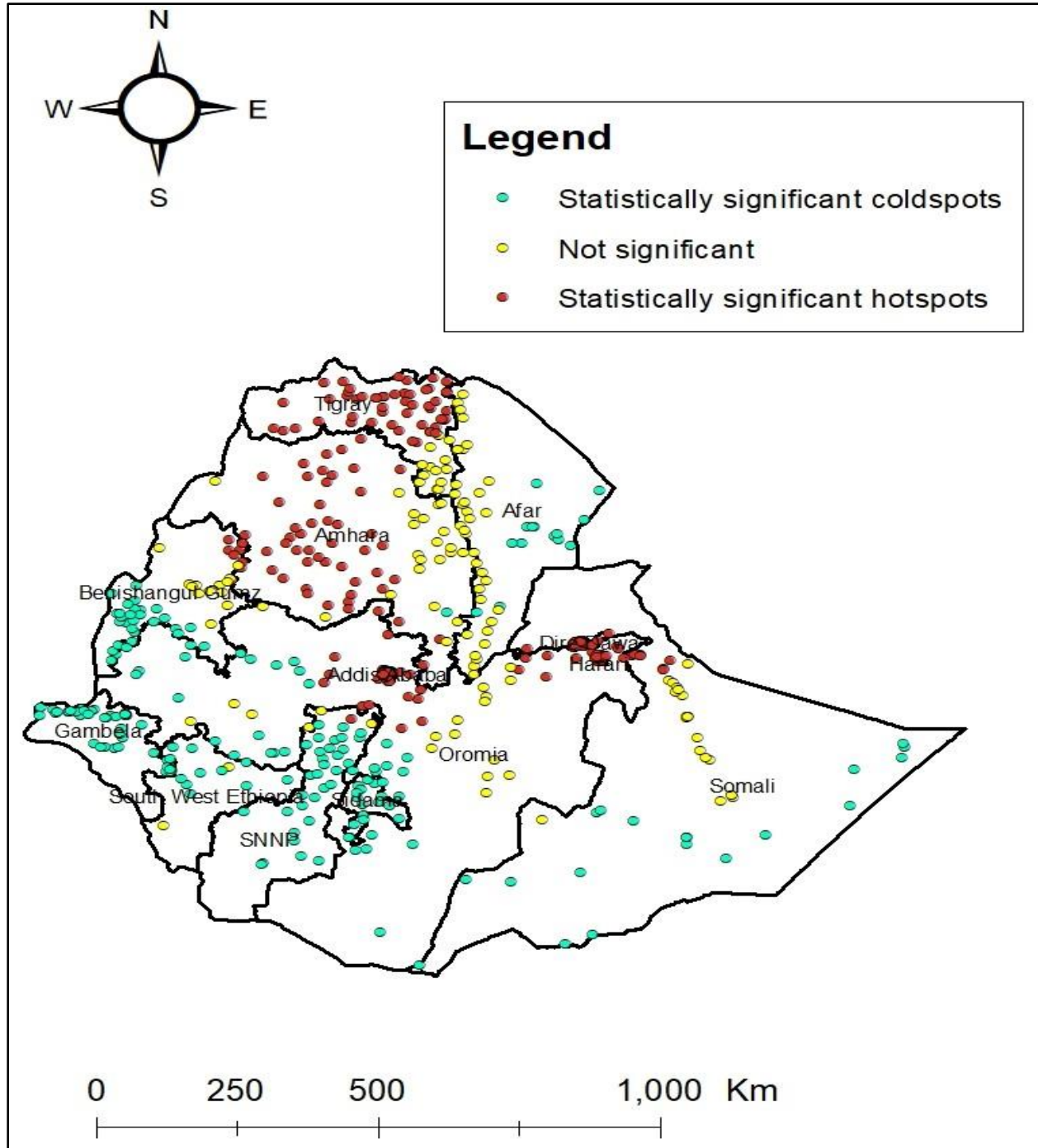
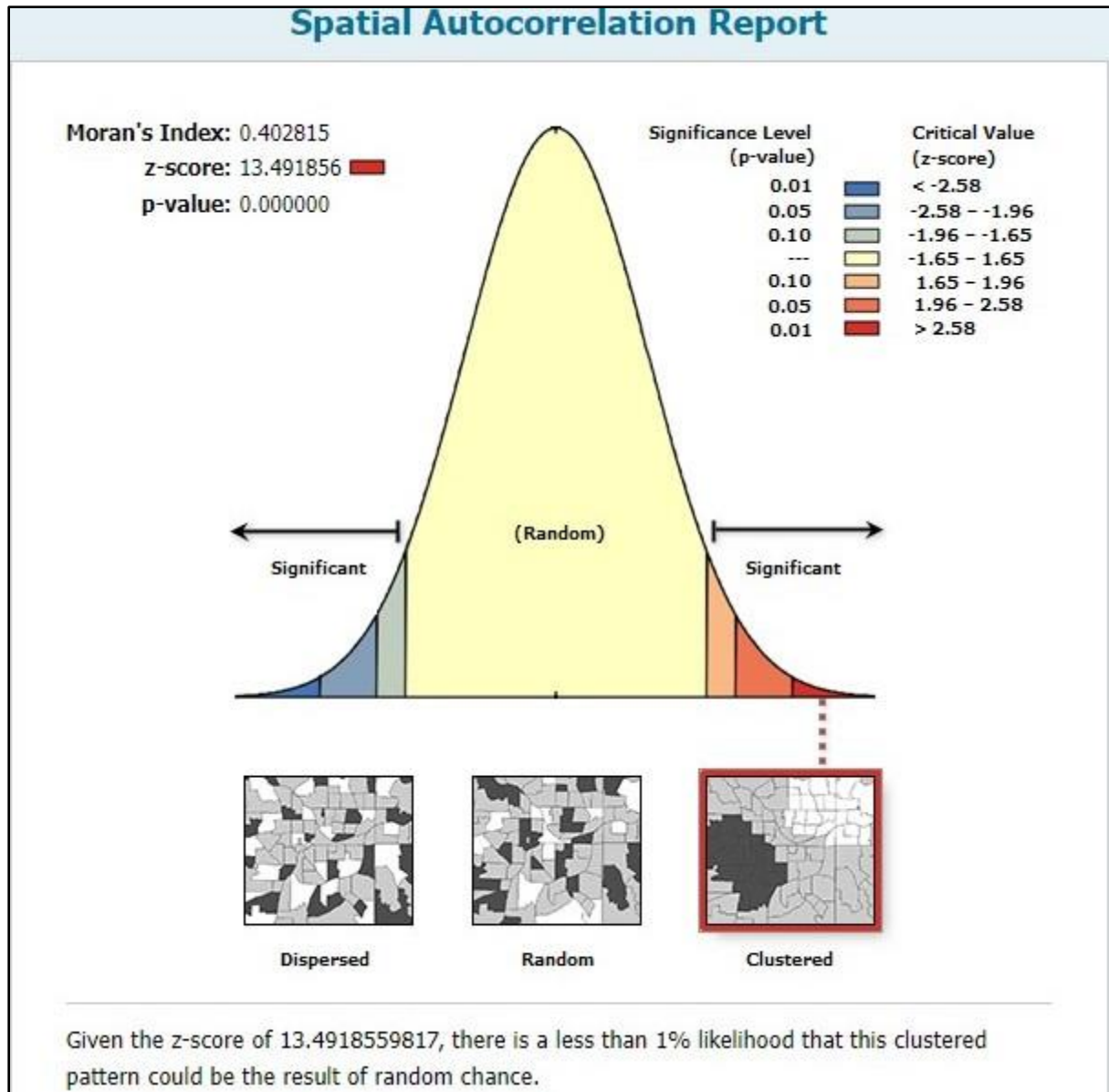


Figure 3: Cold and hotspot analysis of substance use among married men in Ethiopia, EDHS 2016. Source shape file of the map was freely available from <https://africaopendata.org/dataset/ethiopia-shapefiles>.

Global Moran's I Summary	
Moran's Index:	0.402815
Expected Index:	-0.001637
Variance:	0.000899
z-score:	13.491856
p-value:	0.000000
Dataset Information	
Input Feature Class:	combineddataCopyFeatures
Input Field:	SUBSUSE__
Conceptualization:	INVERSE_DISTANCE
Distance Method:	EUCLIDEAN
Row Standardization:	True
Distance Threshold:	122473.3329 Meters
Weights Matrix File:	None

Supplementary file 1 figure: Global Moran's I Summary and dataset information of substance use among married women in Ethiopia, 2016 EDHS.



Supplementary file 2 figure: Autocorrelation report of substance use among married women in Ethiopia, 2016 EDHS.

Number of alive child with Region							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.38	0.70	0.83	1.32	
have 3-5 children	1.24	0.15	1.81	0.07	0.98	1.57	
6 and above children	1.01	0.13	0.07	0.95	0.79	1.29	
_cons	4.36	0.57	11.27	0.00	3.37	5.63	
After region is added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.04	0.12	0.34	0.74	0.82	1.32	
have 3-5 children	1.27	0.15	1.99	0.05	1.00	1.60	
6 and above children	1.06	0.13	0.46	0.65	0.83	1.36	
New_region							
Pastoralist	0.30	0.06	-6.56	0.00	0.21	0.43	
Metropolis	2.16	0.48	3.49	0.00	1.40	3.33	
_cons	5.46	0.88	10.57	0.00	3.98	7.47	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.37	0.71	0.83	1.32	
have 3-5 children	0.94	0.21	-0.26	0.79	0.61	1.46	
have 6 and above children	1.08	0.14	0.61	0.55	0.84	1.39	
New_region							
Pastoralist	0.31	0.06	-6.23	0.00	0.21	0.44	
Metropolis	2.42	0.56	3.79	0.00	1.53	3.82	
childNO1 * region 1	1.45	0.33	1.61	0.11	0.92	2.28	

childNo1 *							
region 2	1.38	0.32	1.37	0.17	0.87	2.18	
childregion3	1.00	(omitted)					
_cons	5.29	0.86	10.20	0.00	3.84	7.29	
Number of children alive and place of residence							
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 children	1.05	0.13	0.40	0.69	0.83	1.33	
have 3-5 children	1.27	0.15	2.00	0.05	1.00	1.61	
have 6 and above children	1.05	0.13	0.36	0.72	0.82	1.34	
Interaction							
Residence							
rural	0.53	0.10	-3.38	0.00	0.37	0.77	
_cons	6.63	1.21	10.40	0.00	4.64	9.48	
Variables	odds ratio	standard error	Z	P-value	95% CI		
NOchil_alive							
have 1-2 childr	1.05	0.13	0.41	0.68	0.83	1.33	
have 3-5 childr	1.31	0.17	2.13	0.03	1.02	1.69	
have 6 and abc	1.06	0.14	0.44	0.66	0.82	1.36	
Residence							
rural	0.51	0.10	-3.45	0.00	0.35	0.75	
Nochil_alive * residence1	0.88	0.16	-0.74	0.46	0.62	1.24	
Nochild_alive * Residence 2	1.00	(omitted)					
_cons	6.81	1.26	10.34	0.00	4.73	9.79	

Age with community level variables						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized	1.09	0.04	2.37	0.02	1.02	1.18
_cons	3.72	0.51	9.65	0.00	2.85	4.86
Age with regions						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized						
25-34	2.11	0.49	3.21	0.00	1.34	3.33
35-44	1.77	0.24	4.27	0.00	1.36	2.31
>=45	1.58	0.22	3.3	0.00	1.20	2.07
New_region						
Pastoralist	0.31	0.06	-6.16	0	0.21	0.45
Metropolis	1.91	0.44	2.79	0.005	1.21	3.01
Products of age and region						
Agecat1 * Pastoralist	0.75	0.17	-1.27	0.20	0.48	1.17
Agecat2 * Metropolis	0.70	0.16	-1.52	0.13	0.45	1.11
Ageregio3	1	(omitted)				
_cons	3.851302	0.667324	7.78	0	2.742319	5.408755
Place of residence with age						
Variables	odds ratio	standard error	Z	P-value	95% CI	
Age categorized						
25-34	1.58	0.23	3.11	0.00	1.18	2.10
35-44	1.68	0.25	3.54	0.00	1.26	2.25
>=45	1.51	0.23	2.74	0.01	1.12	2.03
Interaction of age with palce of residence						
Palce of residence						
rural	0.50	0.10	-3.43	0.00	0.34	0.75
agecat1 * residence1	0.74	0.25	-0.89	0.37	0.39	1.43
agecat 2 * residence2	0.83	0.14	-1.09	0.27	0.59	1.16
resiage3	1	(omitted)				
_cons	5.08	1.12	7.36	0	3.30	7.83

Educational status with region							
Variables	odds ratio	standard error	Z	P-value	95% CI		
primary education	1.13	0.10	1.42	0.157	0.95	1.33	
secondary and above	0.89	0.09	-1.06	0.29	0.73	1.10	
_cons	4.71	0.48	15.07	0	3.85	5.76	
After region added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
primary education	1.13	0.10	1.42	0.157	0.95	1.33	
secondary and above	0.89	0.09	-1.06	0.29	0.73	1.10	
_cons	4.71	0.48	15.07	0	3.85	5.76	
primary education	1.06	0.09	0.73	0.47	0.90	1.26	
secondary and above	0.80	0.09	-2.09	0.04	0.65	0.99	
New_region							
Pastoralist	0.31	0.06	-6.47	0.00	0.22	0.44	
Metropolis	2.32	0.52	3.77	0.00	1.50	3.59	
_cons	6.16	0.83	13.44	0.00	4.73	8.03	
Variables	odds ratios	standard error	Z	P-value	95% CI		
secondary and above	0.67	0.15	-1.85	0.06	0.43	1.02	
New_region							
Pastoralist	0.29	0.05	-6.62	0.00	0.20	0.42	
Metropolis	2.52	0.64	3.66	0.00	1.54	4.14	
edu1 * region1	1.08	0.28	0.31	0.76	0.65	1.81	
Edu1 * region2	1.42	0.36	1.35	0.18	0.86	2.34	
eduregio3	1.00	(omitted)					
_cons	6.28	0.86	13.43	0.00	4.80	8.22	
Educational status with place of residence							
Variables	odds ratio	standard	Z	P-value	95% CI		
primary education	1.10	0.09	1.11	0.27	0.93	1.30	
secondary and above	0.81	0.09	-1.95	0.05	0.65	1.00	
Place of residence							
rural	0.48	0.09	-3.78	0.00	0.33	0.70	
_cons	8.05	1.43	11.77	0.00	5.69	11.39	
primary education	1.10	0.09	1.13	0.26	0.93	1.30	
secondary and above	0.79	0.10	-1.82	0.07	0.60	1.02	
Educational status with place (interaction)							
Variables	odds ratio	standard error	Z	P-value	95% CI		

	Place of residence						
	rural	0.50	0.10	-3.32	0.00	0.33	0.75
	Edu1 * residence 1	1.08	0.21	0.37	0.71	0.73	1.58
	Edu1 * residence 2	1.00	(omitted)				
	_cons	7.82	1.51	10.68	0.00	5.36	11.41

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Occupation with Region							
Variables	odds ratio	standard error	Z	P-value	95% CI		
Occupation	1	1					
Employed	1.42	0.19	2.7	0.007	1.10	1.84	
_cons	3.46	0.51	8.44	0	2.59	4.61	
After region is added							
Variables	odds ratio	standard error	Z	P-value	95% CI		
Occupation							
Employed	1.34	0.18	2.25	0.025	1.04	1.74	
Region							
Pastoralist	0.31	0.06	-6.36	0	0.22	0.45	
Metropolis	2.17	0.48	3.52	0	1.41	3.34	
_cons	4.58	0.82	8.51	0	3.23	6.50	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
New_occup							
yes	0.53	0.20	-1.68	0.093	0.25	1.11	
New_region							
Pastoralist	0.32	0.06	-6.18	0	0.22	0.46	
Metropolis	1.96	0.44	3.04	0.002	1.27	3.04	
Employed * agrarian	0.34	0.16	-2.27	0.023	0.13	0.86	
Employed * pastoralist	0.33	0.14	-2.66	0.008	0.15	0.75	
occuregio3	1.00	(omitted)					
_cons	11.76	4.74	6.11	0	5.34	25.93	
Occupation and place of residence							
Variables	odds ratio	standard error	Z	P-value	95% CI		
occupation							
Employed	1.45	0.19	2.83	0.01	1.12	1.87	
Place of residence							
rural	0.53	0.10	-3.42	0.00	0.37	0.76	
_cons	5.26	1.02	8.57	0.00	3.60	7.70	
Interaction							
Variables	odds ratio	standard error	Z	P-value	95% CI		
occupation							

1							
2	Employed	1.73	0.28	3.35	0.00	1.26	2.38
3							
4	Place of residence						
5	rural	0.34	0.11	-3.49	0.00	0.19	0.63
6	rural * Employed	0.61	0.17	-1.80	0.07	0.36	1.05
7							
8	resioccu2	1	(omitted)				
9	_cons	6.93	1.73	7.74	0.00	4.24	11.32
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