1 **Alcohol consumption, obesity and hypertension: Relationship patterns along different age**

2 **groups in Uganda**

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19 contribution in different ways

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Abstract

Introduction: Uganda is experiencing a significant increase in the prevalence of non-communicable diseases including hypertension and obesity. Frequent alcohol use is also highly prevalent in Uganda and is a key risk factor for both hypertension and obesity. This study determines the trends of frequent alcohol consumption, hypertension and obesity across different age groups, and the extent to which alcohol consumption affects the two.

Methods: The data were extracted from the 2014 National Non-communicable Diseases Risk Factor Survey (N=3,987) conducted among adults aged 18 to 69 years. Hypertension was defined as systolic blood pressure ≥140mmHG or diastolic blood pressure ≥90. Obesity was defined as body mass index >30 kg/m^2. Frequent alcohol consumption was defined as alcohol use 3 or more times a week. Multivariable log binomial regression analysis was carried out for each of the two outcome variables against age group and controlled for frequency of alcohol consumption and few other independent factors. Non-parametric tests were used to compare trends of prevalence ratios across age groups. Modified Poisson regression was use in few instances when the model failed to converge.

Results: The results showed increasing trend in the prevalence of hypertension and frequent alcohol consumption but a declining trend for obesity along different age groups (p<0.01). Frequency of alcohol consumption did not significantly modify the age group-hypertension and age group-obesity relationships although the effect was significant with ungrouped age. There was significance in difference of fitted lines for hypertension prevalence ratios between frequent drinkers and mild drinkers and between abstainers and frequent drinkers. Alcohol consumption did not have any significant effect on obesity-age group relationship.

45   **Conclusion:** The results call for more research to understand the effect of alcohol on the

46   hypertension-age relationship, and the obesity-age relationship. Why prevalence ratios for

47   hypertension decline among those who take alcohol most frequently is another issue that needs

48   further research.

49

50   *Key words: hypertension, obesity, overweight non-communicable diseases, life span, log*

51   *binomial, modified Poisson regression, robust variance estimators*

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55 **Introduction**

56 About 13% of the world's adult population (11% of men and 15% of women) is obese[1] while

57 32% of adults aged more than 24 years are hypertensive[2]. The prevalence of obesity and

58 obesity-related diseases including hypertension are increasing worldwide [3]. These conditions

59 lead to reduced quality of life given their protracted nature, and they also lead to premature

60 deaths, especially due to cardiovascular diseases and diabetes [4]. Once associated only with

61 high income countries, obesity and hypertension are now highly prevalent in low and middle

62 income countries, including Uganda, and are shown to be on the rise[5, 6]. The World Health

63 Organization (WHO) projects the number of hypertension cases in Sub Sahara Africa (SSA) to

64 increase substantially from an estimated 80 million in 2000 to 150 million in 2025[7].

65

66 Alcohol consumption is widely known to be associated with high blood pressure and obesity [5,

67 8-11] both of which are known to increase with age [12, 13]. However, little is known on how

68 alcohol affects high blood pressure and obesity trajectories across age. So far studies have

69 reported varying patterns of relationship between alcohol and hypertension across different age

70 groups. A study in the United States of America, found that in young people aged 18-26, blood

71 pressure reduced among those who took 2-3 drinks a day but rose higher with more or less

72 alcohol intake [14]. In Germany a study found a linear relationship between alcohol intake and

73 blood pressure for only men aged 20-34 and 50-74 and women aged above 49 years[15]. In

74 France a positive relationship between blood pressure and alcohol intake was more evident in

75 under 40 years[16]. A study in Japan found that the elevating effect of alcohol drinking on blood

76 pressure was more prominent in the elderly than in the young[17]. A study in Netherlands found

4

77   a stronger association between alcohol and blood pressure in older men compared with young

78   men[18]. A study in Michigan, USA found that alcohol intake patterns significantly changed the

79   relationship between age and blood pressure[19]. Such varying evidence calls for more localized

80   research that can inform local intervention. Africa has the lowest research output on most health

81   fields but more critically missing is evidence on Non-communicable diseases and their risk

82   factors in the local environment [20].

83   In 2016, 7% of women and 1% of men in age group 15-49 in Uganda were obese [21]. In 2014,

84   the National Non-Communicable Diseases (NCD) Risk Factor Survey found that the prevalence

85   of hypertension was 26.4% and it was associated with Body Mass Index (BMI) > $25kg/m^2$ [6,

86   22]. These estimates are consistent with findings from other studies conducted in smaller

87   populations in Uganda which estimated the prevalence of hypertension to be in the range of

88   14%-35% [11]. On alcohol consumption the country is rated 5th highest consumer in Africa in

89   terms of per capita pure alcohol with an estimated average consumption of 9.8 liters (14.4 liters

90   for males and 5.2 liters for females) of pure alcohol per person per year[23].

91

92   There is a paucity of research on how alcohol affects obesity and hypertension levels across age

93   groups [24, 25] especially in developing countries yet this would inform age group specific

94   intervention. As such, the purpose of this study is to establish the trends of frequent alcohol

95   consumption, hypertension and obesity across different age groups and the extent to which the

96   frequency of alcohol consumption influences the trends of the two.

97

98

Materials and Methods

100   This paper uses secondary data from the National Non-Communicable Disease (NCD) Risk

101   Factor Survey of 2014. The survey included 3,987 participants aged 18-69 and 60% of them

102   were females. The data were collected using the STEPwise approach to surveillance (STEPS).

103   STEPS is a World Health Organization method that provides a standardized method for

104   collection, analysis and dissemination on risk factors for non-communicable diseases (NCD)[22].

105   The survey covered the whole country and used a three stage sampling design to select

106   participants. The first stage involved sampling enumeration areas (EA), followed by random

107   selection of 14 households in each EA and lastly a random selection of one member of household

108   from a list of eligible members. The response rate from the survey was 99% and more details on

109   the methods used can be obtained from the national NCD report or papers written from the

110   mother data set [6, 22].

111

112   For purposes of this study, only relevant variables were provided by the managers of the NCD

113   survey. Key among these variables were frequency of alcohol consumption and amount drank in

114   previous 30 days, height, and weight, biometrics that include hypertension and body mass index,

115   socio-demographic-economic characteristics of the respondents.

116

117   Hypertension is defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90

118   mmHg [26] while obesity is defined as body mass index greater than 30 kg/m^2 [27].

119   Measurements for Systolic and diastolic blood pressure were taken three times and average for

120   each was computed. In the previous study the average was computed for only last 2

121   measurements and the difference is minor. Frequent alcohol consumption was measured as

122   taking alcohol 3 or more times a week.

123

124   We used log binomial regression to model hypertension and obesity with key independent

125   variable being age group and key interaction variable as frequency of alcohol consumption.

126   Binomial models were preferred because they provide prevalence ratios directly. Secondly unlike

127   the alternative logistic regression log binomial models do not overestimate their coefficients

128   when the outcome of interest is a common occurrence[28, 29] although they also have problems

129   of lack of convergence[19] . In the few times non-convergence occurred we used modified

130   Poisson regression which solves the problem but it is not also perfect since it produces

131   inconsistent variances[19]. Stata V14 software was used for analysis.

132

133   Log binomial models are expressed as follows[29]

134

135    $p(y=1\,|\,x)=e^{x'\beta}$

136   ………………………………………………………………………………………………… (1)

137   Where

138        $p=$ Probability of occurrence of an event of interest in this study this is being

139   hypertensive or obese

140        $y=$ Outcome of interest. This can be 1 (occurred) or 0 (did not occur)

141        $x=$ Covariate

142        $x'\beta = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n$. This is the model's linear predictor where the

143   covariates can be continuous or dichotomous.

7

144

145   From the above the prevalence ratio is computed as an exponentiation of the product of the

146   coefficients and the difference in covariate values:

147    $$\frac{p(y=1\,|\,x_1)}{p(y=1\,|\,x_0)} = e^{(x_1-x_0)'\beta}$$

148   For a model with one dichotomous covariate the prevalence ratio is

149    $$\frac{p(y=1\,|\,x=1)}{p(y=1\,|\,x=0)} = e^{\beta}$$

150

151   For modified Poisson regression

152   The following model is fitted but with robust variance estimators that will narrow the confidence

153   intervals of the estimates[30].

154    $g[E(y\,|\,\beta,x)] = \beta_0 + \beta_1 x_1 + ... + \beta_p x_p$

155   Where $P(y\,|\,\beta,x) = \dfrac{e^{-\beta}\beta^y}{y!}$

156    $y = 1,2,3...$

157    $g = $ Link function

158

159   Age was the main independent variable while alcohol consumption was the main modifying

160   factor under investigation. Charts were used to show trends of prevalence ratio for hypertension

161   and obesity across age groups and effect of alcohol consumption.

162

Ethics

The conduct of the National NCD Risk Factor Survey was approved by the Institutional Review Committee of St. Francis Hospital Nsambya, Kampala, Uganda, and registered by the Uganda National Council for Science and Technology. Written informed consent was obtained from eligible subjects before enrollment in the study. Participants with an average systolic blood pressure readings of at least 120 mm Hg, and/or diastolic blood pressure of at least 80mm Hg, reporting not to be on treatment for hypertension, were advised to as soon as possible report to the nearest government owned health facility for further evaluation. The Uganda ministry of health granted permission to use the data for this work.

Results

Characteristics of respondents

175   A total of 2956(74.1%) of the respondents were in the age range 21-50 years. The age

176   distribution did not differ by sex (Table 1). Two thirds were married or in relationship, but

177   marital status varied by sex. Two fifths had attained primary school, but among women a higher

178   proportion did not have any formal education. Nearly two thirds were employed, but among

179   men a higher percentage were employed than among women (75% vs. 58%). The median income

180   per month was 100,000(≈USD 30) and it was significantly higher among men (110,000) (USD

181   ≈33) than women (60,000) (≈18).

182   The level of frequent alcohol consumption (3 or more times a week) was 8.4% but it was

183   significantly higher among men (16%) than women (3.4%). Obesity was at 7.5% and it was

184   higher among women (10.9%) than men (2.4%). Hypertension level was at 18.4% and it did not

185   significantly differ by sex.

186

187   **Table 1: Background Characteristics of the Respondents in NCD Survey**

Characteristics	Male's N (%)	Female's N (%)	All N (%)	Chi-sq. test p-value
Age				
18-20	171(10.7)	257(10.8)	428(10.7)	
21-25	278 (17.3)	392 (16.5)	670 (16.8)	
26-30	261 (16.3)	412 (17.3)	673 (16.9)	
31-35	220 (13.7)	313 (13.1)	533 (13.4)	
36-40	194 (12.1)	267 (11.2)	461 (11.6)	NS-P>0.05

10

41-45	141 (8.8)	204 (8.6)	345 (8.7)	
46-50	97 (6.1)	177 (7.4)	274 (6.9)	
51-55	101 (6.3)	120 (5.0)	221 (5.5)	
56-60	63 (3.9)	96(4.0)	159 (4.0)	
61-65	48 (3.0)	92 (3.9)	140 (3.5)	
66-70	30 (1.9)	53 (2.2)	83 (2.1)	
Marital status				
Single	395 (24.6)	232(9.7)	627(15.7)	
Married/in relationship	1064(66.3)	1580(66.3)	2644(66.3)	
Widowed/other	145(9.1)	570(23.9)	715(17.9)	P<0.001
Education†				
None	123(7.7)	531(22.3)	654(16.4)	
Primary	643(40.1)	983(41.3)	1626(40.8)	
Secondary+	826(51.5)	865(36.3)	1691(42.4)	P<0.001
Work status				
Employed	1216(75.8)	1385(58.1)	2601(65.3)	
Student/unpaid worker	313(19.5)	832(34.9)	1145(28.7)	
Unemployed	75(4.7)	165(6.9)	240(6.0)	P<0.001
Income per month- median (IQR)	110,000(40,000-300,000)	60,000 (20,000-200,000)	100,000 (20,000-200,000)	P<0.01
Drinks alcohol 3 times/more a week	252(15.7)	81(3.4)	333(8.4)	P<0.001
Obese (body mass index >30 kg/m^2)	39(2.4)	259(10.9)	298(7.5)	P<0.001
Has hypertension (blood pressure-systolic $\geq$140mmHg or diastolic$\geq$90)††	441(28.1)	604(25.9)	1045(26.8)	NS-P>0.05

188   †15 refused to provide information   NS- Not significant at 5% level   ††only 3906 had blood pressure measurements.

189 *NB: all the above figures are unweighted*

190

191

Alcohol consumption, hypertension and alcohol consumption across different age groups

194 Fig 1 shows the trend of frequent alcohol consumption, hypertension and obesity across age

195 groups. The levels of hypertension and frequent alcohol consumption rise with age group and

196 almost at the same average gradient until 46-50 years when the prevalence of hypertension rises

197 higher. The level of obesity reduces with age group to near zero in age group 51-55 when it rises,

198 but at a lower gradient. Values for all the three indicators start at nearly the same level and

199 sharply diverge after 26-30 year age group. A significant test of the gradient of each of the

200 trends in the figure below showed significance (p<0.01).

201

202 *Fig 1: Levels of hypertension, obesity and frequent alcohol consumption across different age*

203 *groups*

204

205

Effect of alcohol on the Hypertension- age relationship

207 The prevalence ratios for hypertension rose by age group and this persisted after controlling for

208 frequency of alcohol consumption and other key factors (Table 2). A test of significance of an

209 interaction between frequency of alcohol consumption, hypertension and age group did not yield

210 any significance at 5% level but when age group was replaced with age in single years it was

12

211   significant. This shows that the relationship between alcohol consumption and hypertension

212   significantly changed by single year rather than by age group.

213

214   **Table 2: Hypertension Prevalence ratios along different age groups and other factors**

215

Characteristics	Prevalence N (%)	Un-adjusted Prevalence ratio	Prevalence ratio adjusted for alcohol consumption
Age			
18-20	53(12.7)	1.0	1.0
21-25	119 (18.1)	1.43 (1.06-1.93)*	1.52 (1.12-2.06)**
26-30	139(21.1)	1.67 (1.25-2.23)**	1.84 (1.36-2.49)***
31-35	123(23.5)	1.86 (1.38-2.50) ***	2.10 (1.53-2.86)***
36-40	116(25.6)	2.02 (1.50-2.72) ***	2.27(1.66-3.12) ***
41-45	104(31.3)	2.48 (1.84-3.34) ***	2.80(2.03-3.85) ***
46-50	110(40.6)	3.21 (2.40-4.29) ***	3.65(2.67-4.99) ***
51-55	92(42.0)	3.32 (2.47-4.46) ***	3.76(2.73-5.17) ***
56-60	82(53.3)	4.21 (3.14-5.64) ***	4.71 (3.44-6.46) ***
61-65	64(46.0)	3.64 (2.67-4.96) ***	4.12 (2.94-5.77) ***
66-70	43(54.4)	4.30 (3.12-5.94) ***	4.76 (3.38-6.72) ***
Drinks alcohol 3 times/more a week			
3+ times weekly	104(32.0)	1	1
<3 times weekly	292(28.8)	0.90(0.75-1.08)	1.05 (0.88-1.26)

No/doesn't drink	649(25.3)	0.79 (0.67-0.94)**	1.01 (0.85-1.20)
Sex			
Male	441(28.0)	1	1
Female	604(25.9)	0.92 (0.83-1.02)	0.97 (0.87-1.08)
Marital status			
Single	128(20.9)	1.0	1
Married/in relationship	675(26.0)	1.25 (1.05-1.47)*	0.79 (0.66-0.95)*
Widowed/other	242 (34.8)	1.67 (1.39-2.01)***	0.82 (0.66-1.02)
Work status			
Employed	108(27.9)	1.0	--
Self employed	594(27.5)	0.98 (0.83-1.17)	--
Student/unpaid worker	270(24.1)	0.86 (0.71-1.04)	--
Unemployed	73(30.9)	1.11 (0.86-1.42)	--
Education†			
None	194(30.4)	1.0	--
Primary	429(26.8)	0.88(0.76-1.02)	--
Secondary+	316(24.6)	0.81(0.70-0.94)**	--
Tertiary	101 (27.9)	0.92(0.75-1.13)	--
Average Income per month			
<=500,000	252(27.1)	1	
>500,000	19(28.4)	1.05 (0.71-1.56)	--

216   *†15 refused to provide information. – left out because Wald test showed p>0.1*

217

218   Fig 2 shows the ratio of prevalence of hypertension at each age group to that at base age group of

219   18-20 by frequency of alcohol consumption. It's evident that after 40 years the hypertension

220   prevalence ratio across age groups among frequent drinkers was persistently lower than that

221   among those who did not take alcohol or drank moderately while trends for those who drank

222   moderately and those who never drank kept a steady rise at almost equal gradient. Beyond 60

223   years the ratio among the frequent drinkers dropped sharply to 0.8 rose slightly to 2.3.

224

225   **Fig 2: Prevalence ratios for Hypertension across age groups by frequency of alcohol**

226   **consumption among both men and women**

227

228   A closer examination of trends of prevalence ratios across age groups by sex showed that the

229   prevalence of hypertension across age groups is relatively lower among men that don't take

230   alcohol while it's the opposite among women (Fig 3). A Wilcoxon's rank sum test for the

231   difference was significant for men (p=0.03) but not for women (p>0.1). The figure left out those

232   who drank most frequently because they were too few to split by sex across age groups.

233

234   **Fig 3- Prevalence ratios for Hypertension across age groups by frequency of alcohol**

235   **consumption and by sex**

236

237   Fig 4 shows fitted lines for prevalence ratios for hypertension at different age groups by alcohol

238   consumption patterns. The figure complements results in Fig 2 and shows an interaction of

239   drinking pattern on hypertension-age group relationship which was not significant on use of age

240   group but significant on use of single year age.

15

241

242   **Fig 4: Fitted prevalence ratios for hypertension across different age groups by alcohol**

243   **consumption pattern**

244

245   A Wilcoxon's signed rank test of significance between the trends for drinking 3+days weekly &

246   <3 days weeks showed a significant difference (p<0.001). The same level of significance was

247   established with comparison of the trends for drinking 3+ weekly &   No alcohol. Each of the

248   fitted lines had a statistically significant gradient.

249

250   # Obesity

251   Fig 5 shows the trend of prevalence of obesity across all age groups. The prevalence of obesity

252   among women starts high up from around 18% in the age group 21-25 and declines to around

253   1% at the age group of 46-50 years while that among men starts low at 3.6% and reduces to 3.1%

254   in the same period. The test for the difference in the two trends using Wilcoxon's rank sum test

255   shows a p-value of p=0.016.

256

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258

259   **Fig 5: Prevalence of obesity by sex across age groups**

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263

264   Table 3 shows prevalent ratios for obesity. The prevalence ratios of obesity reduced with

265   increasing age groups even after controlling for drinking patterns and marital status which were

266   significant in the bivariate analysis. A test of interaction with frequency of alcohol consumption

267   did not show any significance hence lack of influence on the obesity-age group relationship.

268   **Table 3: Obesity Prevalence ratios in different age groups and other factors**

269

Characteristics	Prevalence N (%)	Un-adjusted Prevalence ratio	Prevalence ratio adjusted for alcohol consumption
Age			
18-20	39 (9.1)	1.00	1.0
21-25	79 (11.8)	1.29 (0.90-1.86)	1.05 (0.74-1.51)
26-30	76 (11.3)	1.24 (0.86-1.79)	0.91 (0.63-1.32)
31-35	40(7.5)	0.82 (0.54-1.26)	0.61 (0.40-0.78)**
36-40	26 (5.6)	0.62 (0.38-1.00)*	0.47 (0.29-0.76)***
41-45	17 (4.9)	0.54 (0.31-0.94)*	0.40 (0.23-0.69) ***
46-50	5 (1.8)	0.20 (0.08-0.50)**	0.14 (0.06-0.36) ***
51-55	2 (0.9)	0.10 (0.02-0.41)**	0.08 (0.02-0.33) ***
56-60	5(3.14)	0.35 (0.14-0.86)*	0.27 (0.11-0.68)**
61-65	4 (2.9)	0.31 (0.11-0.86)*	0.23 (0.08-0.65)**
66-70	5 (6.0)	0.66 (0.27-1.63)	0.41 (0.15-1.14
Sex			
Male	39(2.4)	1	1
Female	256 (10.9)	4.47 (3.21-6.22)***	4.23 (3.00-5.97)***

17

Drinks alcohol 3

times/more a week

3+ times weekly	16(4.8)	1	1.00
<3 times weekly	72 (6.9)	1.44 (0.85-2.74)	0.74 (0.44-1.23)
No/doesn't drink	210 (8.0)	1.67 (1.02-2.74)*	0.69 (0.42-1.13)

Marital status

Single	25 (4.0)	1	1.00
Married/in relationship	235 (8.9)	2.23 (1.49-3.34)***	2.41 (1.58-3.68)***
Widowed/other	37 (5.2)	1.30 (0.79-2.13)	1.71 (1.00-2.91)*

Work status

Employed	29 (7.2)	1	
Self employed	147 (6.7)	0.93 (0.63-1.36)	--
Student/unpaid worker	106(9.3)	1.29 (0.87-1.91)	--
Unemployed	15 (6.2)	0.87 (0.48-1.59)	--

Education†

None	41 (6.3)	1.00	--
Primary	127 (7.8)	1.25 (0.89-1.75)	--
Secondary+	106 (8.1)	1.28 (0.91-1.82)	--
Tertiary	22 (5.9)	0.94 (0.57-1.55)	--
Refused	1 (6.7)	1.07 (0.15-7.22)	--

Average Income per

month

<=500,000	75 (7.8)	1.00	--

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>500,000	3 (4.4)	0.56 (0.18-1.72)	--

270 †15 refused to provide information.

271 NB: interaction terms for alcohol consumption on hypertension-AGE relationship were not significant even after running the

272 models by sex

273

274 Fig 6 shows the trend for obesity levels over age groups by frequency of alcohol consumption.

275 The chart confirms results from table 3. There is a general declining trend of obesity across the

276 age groups and it did not significantly vary by frequency of alcohol consumption.

277

278 **Fig 6: Prevalence ratios for obesity across age groups by frequency of alcohol consumption**

279

280

281

Discussion

283   This study explored relationship patterns of alcohol with hypertension and obesity across

284   different age groups. The findings show that the prevalence of frequent alcohol consumption and

285   hypertension follow a nearly similar increasing trend across all age groups below 50 years while

286   the prevalence for obesity follows a downward trend. The relationship between frequent alcohol

287   consumption and hypertension is significant and it changes significantly by age in single years

288   but not by 5 year age groups. The relationship between frequent alcohol consumption and

289   obesity is not significant and does not change across different age groups. Across all age groups

290   the prevalence of hypertension among frequent drinkers is lower than those who either don't

291   drink or drink less. While among men it's the non-drinkers that have low prevalence of

292   hypertension it's the opposite among women.

293   The increasing trends of frequent alcohol consumption and hypertension across age groups are

294   consistent with several studies in different parts of the world [31] but inconsistent with studies in

295   some other communities[32]. The increasing trend for alcohol consumption can be explained by

296   increased access and ability to buy alcohol which may reduce after 50 years due to change in

297   lifestyle, working environment and social network. Another view could be threshold effect where

298   frequent alcohol consumption exacerbates physiological damages that may also lead to

299   hypertension. However, we noticed that among those who used alcohol frequently, the

300   prevalence ratios rose sharply, dropped and rose again. Future research may examine this pattern

301   more specifically and address other contextual factors not addressed in this study including

302   potential cohort effects, age since alcohol initiation and other potential factors that can impact

303   these findings.

304   The strong relationship between frequent alcohol consumption and hypertension is reported in

305   many studies [33] and some affirm a causal relationship[34]. However, the change in this

306   relationship with single years and not 5 year age groups is what needs to be investigated further.

307   The prevalence of obesity reduces with age groups but this is more evident among women where

308   it declines sharply between age groups 21-25 and 46-50. This contrasts with studies that show

309   increasing trend of obesity with age group among women in other countries [35, 36] but others

310   show decline with age[37, 38]. While some studies have found a significant positive relationship

311   between alcohol consumption and obesity[39] this study did not find such relationship

312   significant. The negative association between age and obesity can be partially explained by the

313   lower life expectancy observed in Uganda compared to populations examined elsewhere as well

314   as a potential cohort effect of the older participants in this study.

315   Lower prevalence of hypertension among frequent alcohol consumers compared to the abstainers

316   and infrequent drinkers is an issue that needs further investigation. One probable explanation is

317   the low number of respondents that were frequent alcohol consumers. In subsequent analysis by

318   sex the frequent consumers were left out because of small numbers.

319   **Conclusion**

320   We conclude, firstly, that the prevalence of frequent alcohol consumption increases across the

321   age groups at almost the same level with prevalence of hypertension until 50 years of age.

322   The frequency of alcohol consumption did not significantly modify the age group-hypertension

323   and obesity-age group relationships but the effect was significant with single years.

324   The prevalence of hypertension among frequent alcohol consumers is lower than that among

325   abstainers and infrequent/mild drinkers. This calls for further research as this is inconsistent with

326   several studies.

327   While among men it's the non-drinkers that have lower prevalence of hypertension than the mild

328   drinkers across age groups it's the opposite among women although the difference is not

329   significant as in the case with the men. More research is needed to identify causes behind this

330   difference.

331   Programs aimed at reducing hypertension should include messages on abstinence from alcohol

332   consumption especially among men. Priority should also go to older persons.

333   Frequent alcohol consumption is a key factor in the prevalence of hypertension among most age

334   groups examined, but particularly among those ages 40 and above. Frequent drinking is a

335   modifiable factor that needs to be addressed within clinical practice. Typically, while treatment

336   protocols may include counseling patients on the risk of alcohol, it is not clear whether doctors

337   or health care providers in Uganda have fully embraced or implemented alcohol reduction

338   strategies such as alcohol screening and brief interventions in their treatment of hypertension (is

339   this true). However, this modification to current clinical practice should be explored and

340   investigated further. Moreover, additional research is needed to determine the biological

341   mechanism linking alcohol use to hypertension and what factors exacerbate this association

342   among adults in their 40-50s.

343   These findings underscore the importance of examining alcohol use in the context of non-

344   communicable diseases in order to determine prevention and intervention strategies.

345   **Limitations**

346   Our findings should be considered in the context of several limitations. First and foremost, the

347   data are self-reported and as such, inherent biases or lack of knowledge about certain health

348   conditions may have yielded an underestimate of both obesity and hypertension. Moreover,

349   while disclosing alcohol use is not considered a sensitive matter, study participants across

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350   settings often under report actual use. Most likely these limitations yield an underestimate of the

351   true association between alcohol use, hypertension and obesity than what has been reported in

352   this study. Moreover, the analyses were based on a cross sectional survey and as such we could

353   not measure the timing and prospective association of the associations between alcohol use and

354   hypertension and obesity which would be of great importance for future prospective cohort

355   studies. Finally, we included several potential confounders in our analyses. However, there may

356   be other important variables that were not considered or available for analyses.

Ethics

358   The principal investigator obtained a written permission to use the secondary data from the

359   management of the non-communicable diseases risk factor survey of 2014.

Acknowledgement

361   We thank the investigators and sponsors of the Uganda National Study of Non-Communicable

362   Diseases risk factor survey of 2014. We further thank all staff and participants in the study

363   without their good work; we would not prepare this report.

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Figure 1: Levels of hypertension, obesity and frequent alcohol consumption across different age groups
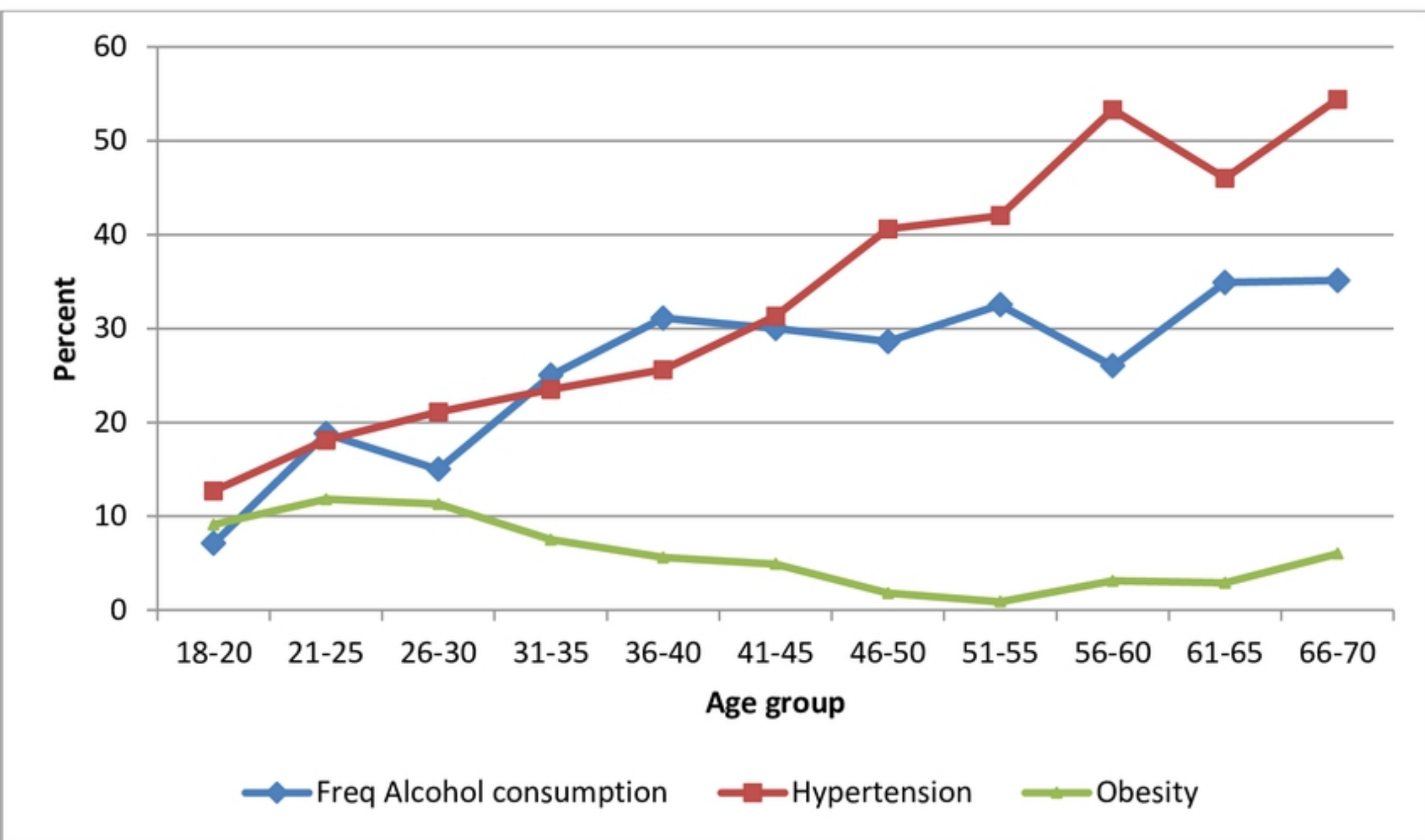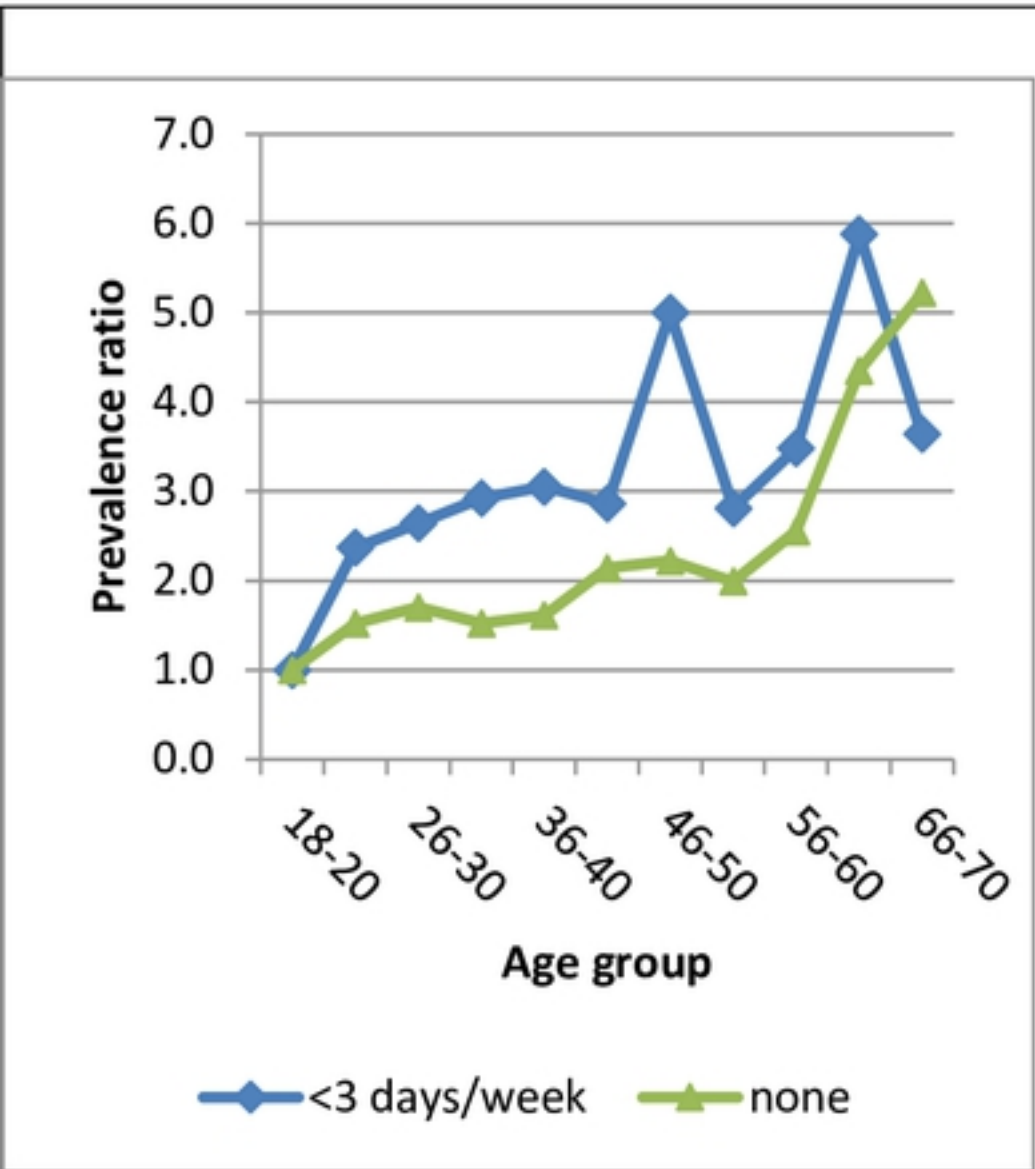

Figure

Figure 2: Prevalence ratios for Hypertension across age groups by frequency of alcohol consumption among both men and women
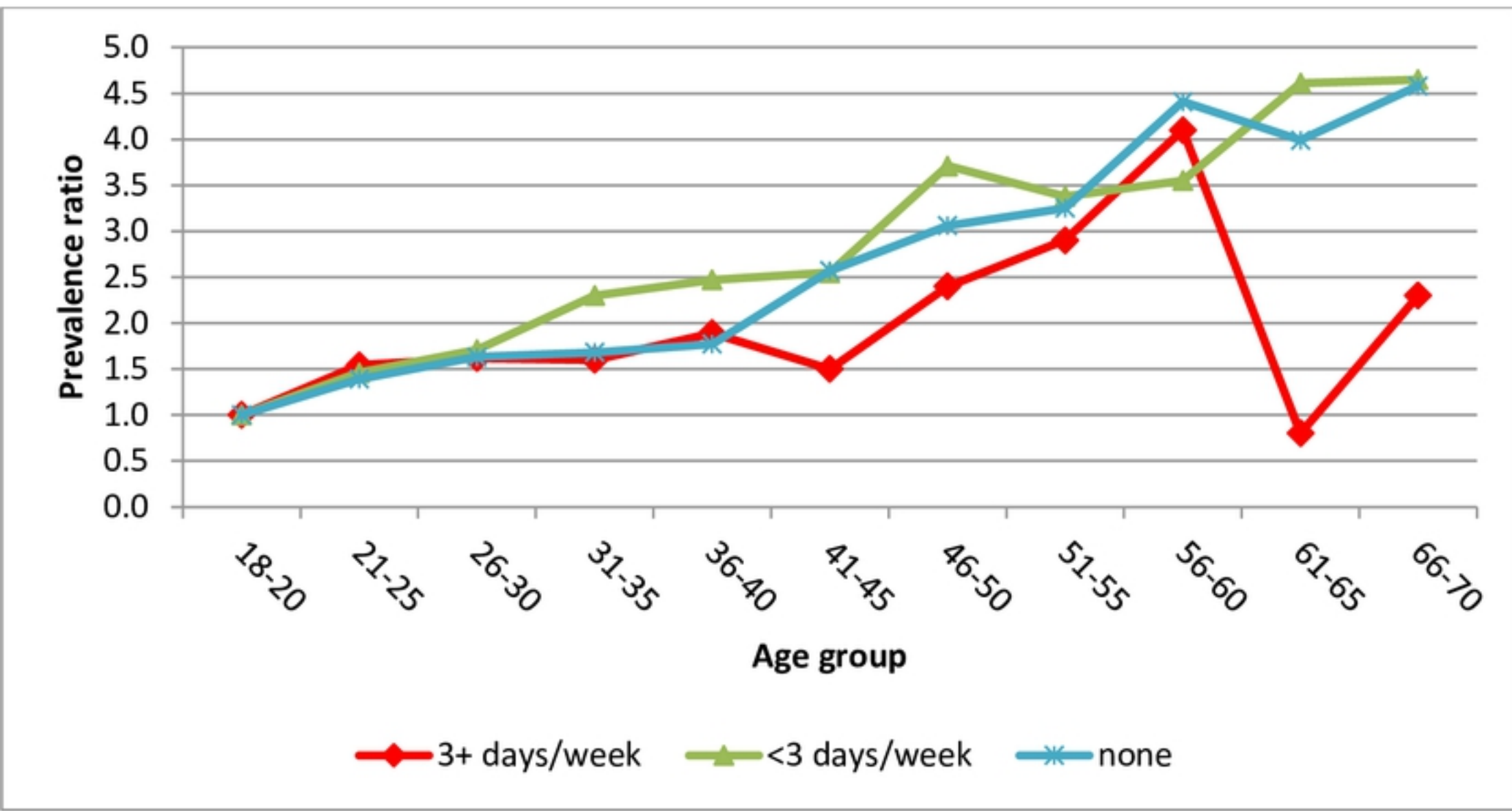
Figure

Figure 3: Prevalence ratios for Hypertension across age groups by frequency of alcohol consumption and by sex
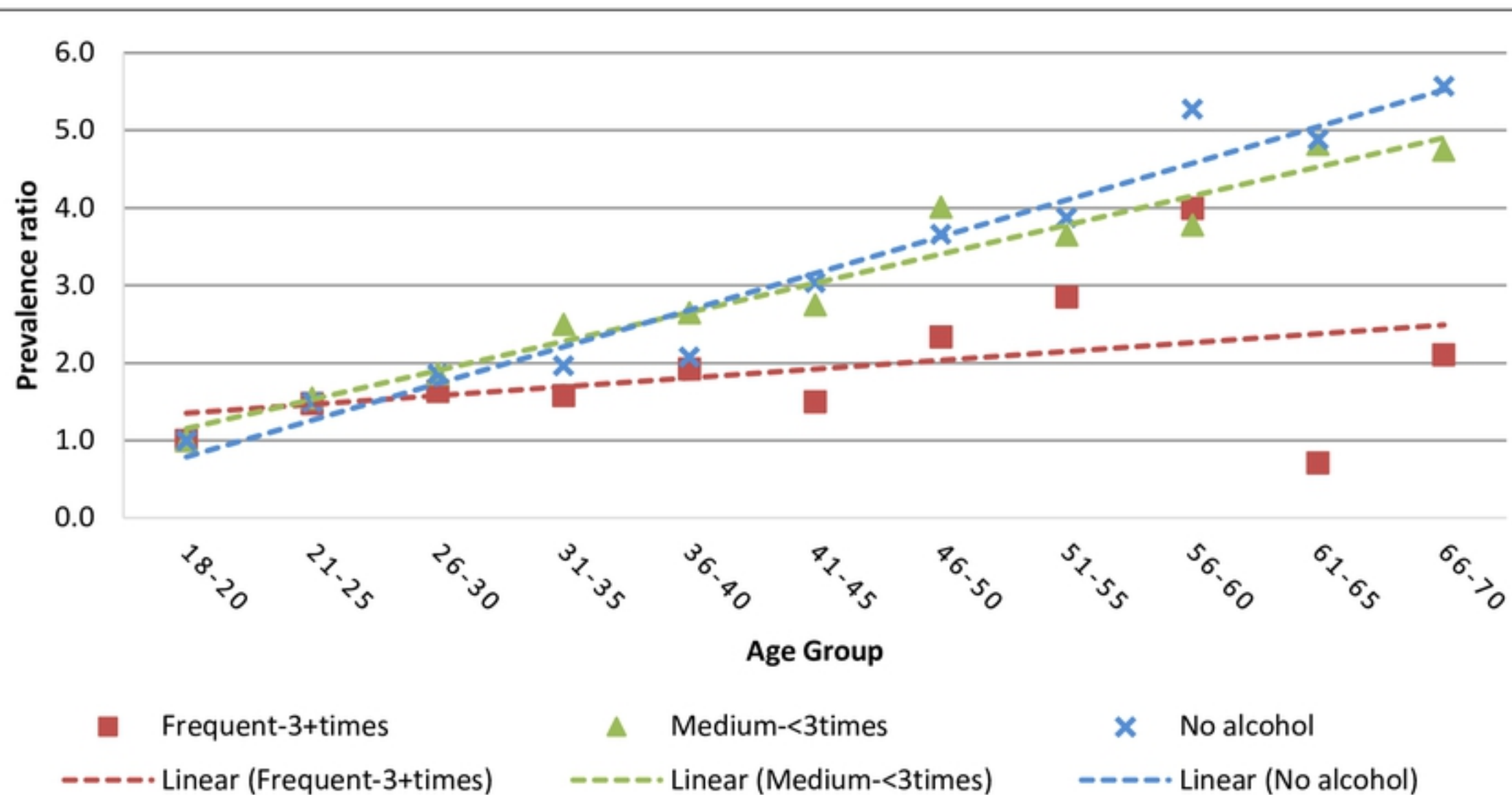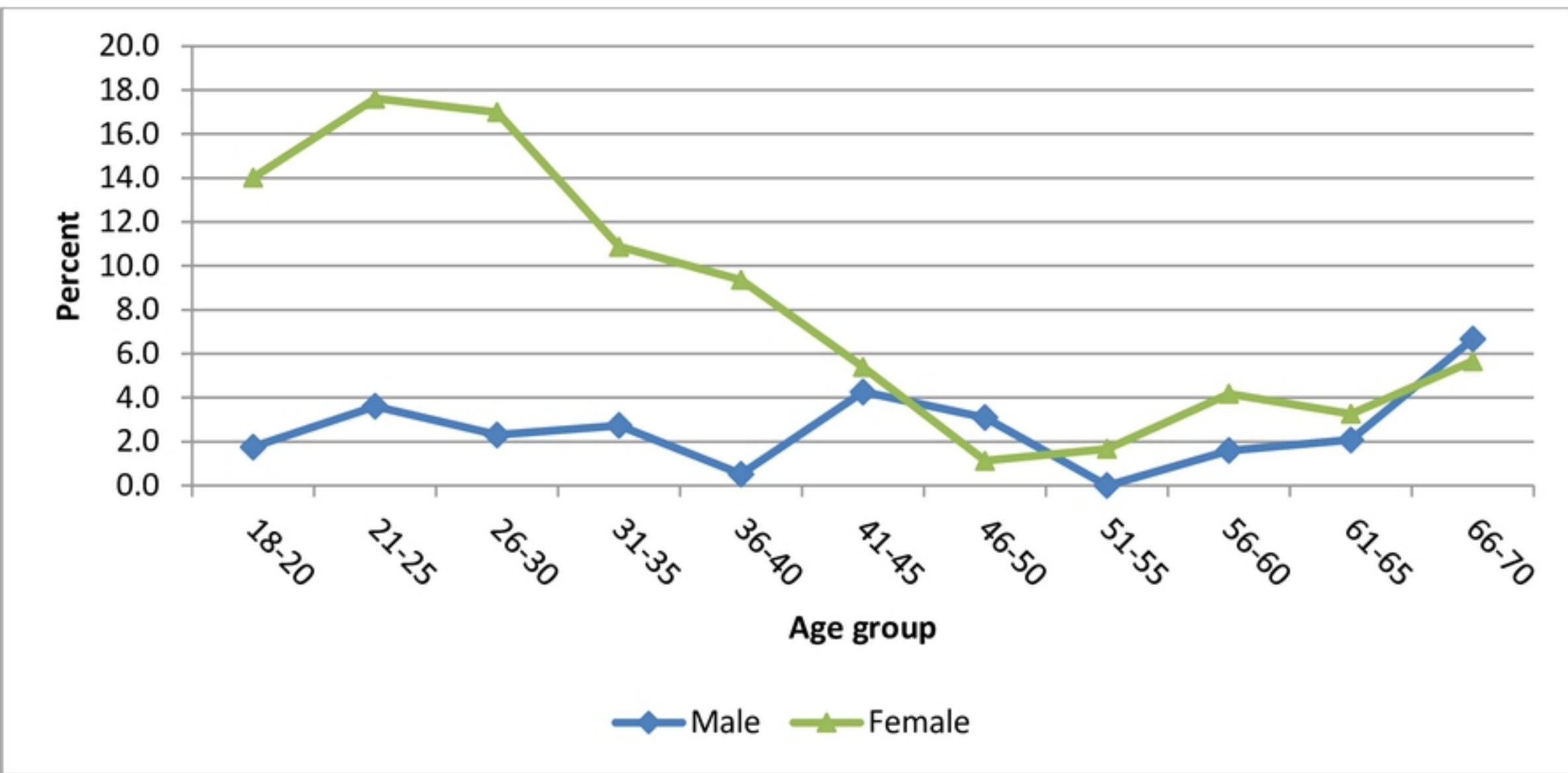

Men
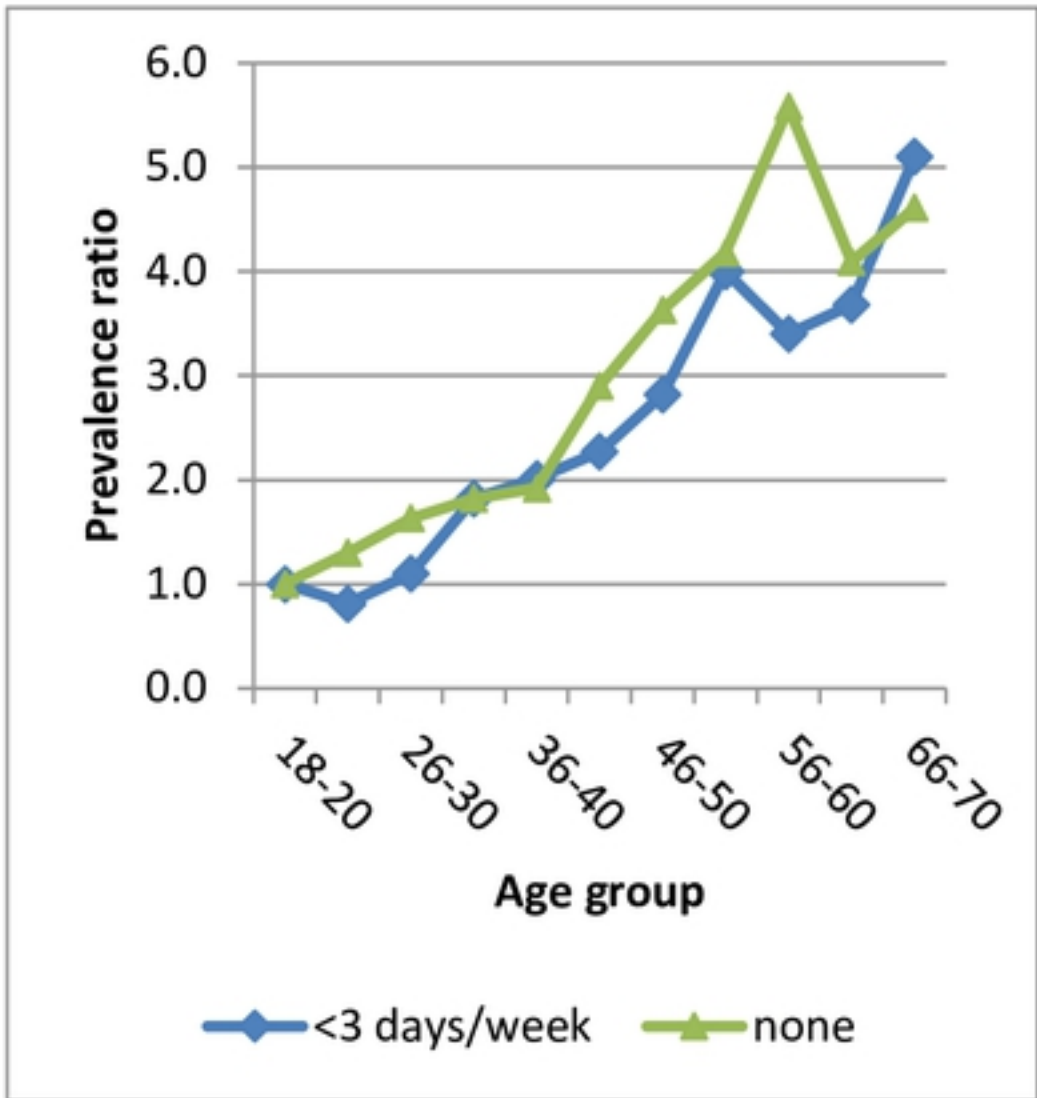
Women

Figure

Figure 4: Fitted Prevalence ratios for hypertension across different age groups by alcohol consumption pattern
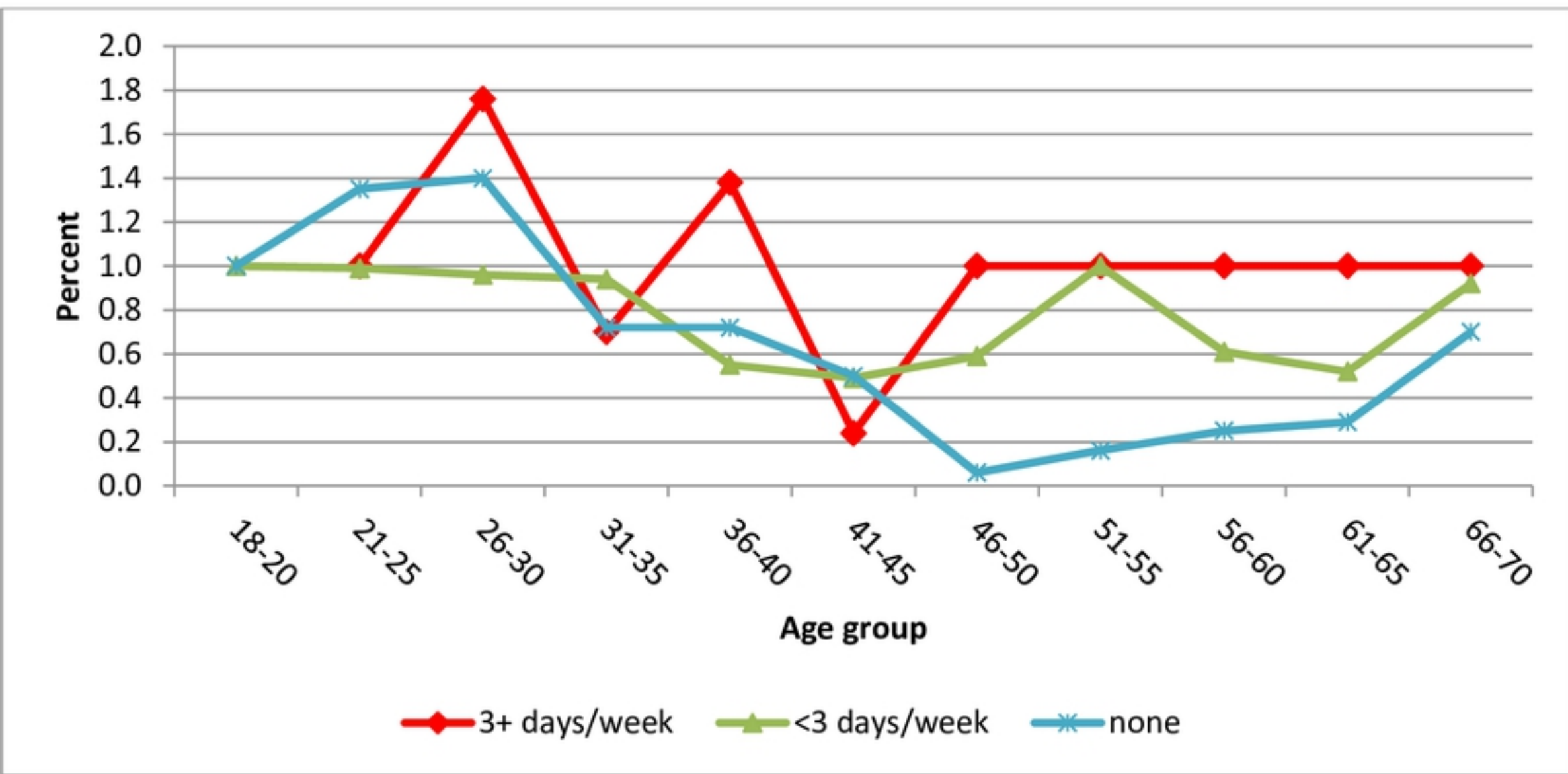

Figure

Figure 5: Prevalence of obesity by sex across age groups

Figure

Figure 6: Prevalence ratios for obesity across age groups by frequency of alcohol consumption

Figure