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1   Title: Self-report Poor Oral Health and Chronic Diseases: The Hong Kong FAMILY Project

2   Running head: Self-report Poor Oral Health and Chronic Diseases

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ABSTRACT

Objectives: To assess the association between self-reported oral health (SROH) and general health, this study examined the cross-sectional associations between SROH and nine chronic health conditions, namely cancer, diabetes, high blood pressure, high cholesterol, thyroid disease, nervous system disease, eye/nose/throat disease, stomach/intestinal disease, and musculoskeletal disease in Hong Kong.

Methods: This study included 41,641 participants recruited in the FAMILY Project cohort study during March 2009 to March 2011. SROH was measured on a 5-point Likert scale. Multiple logistic regression model was used to analyze the effect of dichotomized SROH (0: very good/good/average, 1: bad/very bad) on nine chronic health conditions, adjusted for age, sex, education, personal income, smoking and drinking habits, BMI, and blood pressures.

Results: All the nine chronic health conditions investigated were associated with SROH. SROH showed the strongest cross-sectional association with nervous system disease (odds ratio = 3.30, $p < 0.001$), while the odds ratio with other significant chronic health conditions ranged from 1.13 (high cholesterol, $p = 0.033$) to 1.73 (stomach/intestinal disease, $p < 0.001$).

Conclusions: Poor SROH is associated with cancer, diabetes, high blood pressure, high cholesterol, thyroid disease, nervous system disease, eye / nose / throat disease, stomach / intestinal disease, and musculoskeletal disease.

Keywords: chronic disease; dentistry; diabetes; epidemiology; hypertension; survey

INTRODUCTION

Oral health (OH) has often been considered in isolation of other health problems despite growing

recognition that OH is an integral part of general health (1). It has long been accepted that oral

health conditions themselves may give rise to and/or exacerbate existing general health problems,

most notably diabetes, cardiovascular, and respiratory problems (2-4). Furthermore, more

recently evidence is emerging to suggest that management of oral health problems can prevent

and/or improve control of general health problems, for example glycemic control and aspiration

pneumonia (5, 6).

Evidence of the association between oral health and general health has been obtained largely

from relatively small clinical samples of patients attending dental clinics or patients at medical

centres with specific general health problems. Several epidemiological studies have investigated

the association between general and oral health (7, 8) but are limited in terms of small sample

size and breath of general health aspects considered. Thus, the effects of specific oral health

conditions and specific general health problems have tended to be the focus of interest. Hence,

comprehensive exploration of the relationship of OH and general health is warranted. For the

promotion of OH as an integral component of general health, there is a need to consider the

association of OH with general health problems in the population as a whole to raise both inter-

professional and public awareness (9).

By making use of the survey data from more than 40,000 participants, a sample size much larger

than any of the aforementioned national surveys, we report for the first time the relationship

between SROH and chronic health conditions. We hypothesize that poor SROH is associated

70   with chronic health conditions. To test our hypothesis, we explore the association between self-

71   reported oral health (SROH) with nine common chronic health conditions, namely cancer,

72   diabetes mellitus (DM), high blood pressure, high cholesterol, thyroid disease, nervous system

73   disease, eye / nose / throat (ENT) disease, stomach / intestinal disease, and musculoskeletal

74   disease in a Chinese population-based study.

75

76   **MATERIALS AND METHODS**

77   **Participants**

78   The design of this study was a large scale cross-sectional survey. The sample was derived from

79   the FAMILY Project cohort study, funded by a local charity, the Hong Kong Jockey Club

80   Charities Trust, as an initiative to promote family health, happiness and harmony in Hong Kong.

81   Families, defined as a group of persons living at the same address, were recruited from March,

82   2009 to March, 2011; all members aged 15 years or above living at the same address had to

83   agree to participate. The cohort was designed to cover about 20,000 households, including about

84   1% of the Hong Kong population. Details of the sampling and interview have been described in

85   the FAMILY Project website (http://www.family.org.hk/household-survey) and elsewhere (10).

86   Written consent was obtained from participants (parental consent was also obtained for

87   participants under 18) and this study was approved by the Institutional Review Board of the

88   University of Hong Kong (reference number UW 09-387).

89

90   **Measurements**

91   *Single item SROH.* Participants were asked to rate their OH in a 5-point Likert scale (1: very

92   good; 5: very bad). It was validated against other SROH scales (11).

93

Health behaviors. Current smoker was defined using a self-report item. Excess drinker was

defined as consumption at least 210 g (male) / 140 g (female) of alcohol per week derived from a

beverage frequency questionnaire (12).

97

Body Mass Index and blood pressures. Height (using the SECA 214 stadiometer,

http://www.seca.com), weight (using the Omron fat analyzer scale HBF-356, http://www.omron-

healthcare.com.sg), and systolic (SBP) and diastolic (DBP) blood pressures (using the Omron

electronic blood pressure monitor HEM-7000, http://www.omron-healthcare.com.sg) were

measured by trained interviewers following standard protocols. Body Mass Index (BMI) was

calculated as weight (kg) divided by the square of height (m^2). Obesity was defined as BMI ≥25

(Asian standard). The means of two measurements of SBP and DBP with five minutes apart were

used.

106

Chronic health conditions. Participants were asked whether they had been diagnosed with cancer,

diabetes mellitus (DM), high blood pressure, high cholesterol, thyroid disease, nervous system

disease (e.g. epilepsy, Parkinson's disease), eye / nose / throat (ENT) disease (e.g. sinusitis,

allergic rhinitis, tinnitus), stomach / intestinal disease (e.g. gastric ulcer), and musculoskeletal

disease (e.g. arthritis, gout, osteoporosis) by a medical practitioner. We also recorded self-

reported medicine use for those who reported a chronic health condition, as a validation of the

reported of chronic conditions. More than 95% of the participants self-reported having chronic

diseases also reported taking the corresponding medicine, supporting face validity of the self-

report chronic disease items.

116

117   *Social desirability*. Social desirability was measured using 6 items from the 17-item Social

118   Desirability Scale (13). Participants decide whether the statement described in the 6 items pertain

119   their personality with a true/false response.

120

121   *Other covariates.* Tertiary education was defined as having a bachelor's degree or further

122   education. Personal income was defined as the monthly combined income from all sources.

123   These two covariates were used as measures of socio-economic status.

124

125   **Statistical Analysis**

126   We excluded from the analyses 90 participants who did not answer the self-reported OH item,

127   leaving a final sample size of 41,666. Age-sex weighting according to the 2010 Hong Kong

128   population data from Census and Statistics Department of Hong Kong was applied to the sample,

129   and the sample size became 41,641 as a result of the weighting. One way analysis of variance

130   (ANOVA) and its *p*-value for trend were used to examine the association and linear trend

131   respectively between SROH and continuous factor (age), as there is clear evidence on the

132   linearity between age and poor oral health (participants were divided into six groups (age 15-24,

133   25-34, 35-44, 45-54, 55-64, 65+), and the prevalence of self-report poor oral health for these six

134   groups were 7.0%, 8.4%, 10.7%, 13.0%, 17.3%, and 21.4% respectively). Pearson χ^2 test and its

135   *p*-value for trend were used to examine the association and linear trend respectively between

136   SROH and dichotomous factors, for example sex and income. Three sets of multiple logistic

137   regression models was used to analyze the association between dichotomized SROH as

138   independent variable (0: very good / good / average, 1: bad / very bad) and chronic health

139   conditions as dependent variables, the first set adjusted for age and sex, the second set adjusted

140   further on education, income, health behaviors, BMI, and blood pressures, and the last set

141   adjusted further on social desirability. All statistical analysis was performed using Predictive

142   Analytics SoftWare (PASW 18.0, formerly known as SPSS).

143

144   **RESULTS**

145   Of the 41,641 participants included in the present analysis, 34.6% rated their OH as very good /

146   good, 52.4% as average, and 13.0% as bad / very bad (Table 1). 26,643 (64.0%) of them were

147   married, and 5,551 (13.3%) of them had attained tertiary education. These demographic

148   characteristics were very similar to the Hong Kong population (57.7% married, 18.0% attained

149   tertiary education) (14). There were significant increasing trends between self-report OH and all

150   demographic variables (Table 1), between SROH and health behaviors (Table 1), between health

151   behaviors and all chronic health conditions (Table 2), and between SROH and all chronic health

152   conditions (Table 3). Older participants, male, those without tertiary education, with personal

153   income less than 20,000 Hong Kong dollar (1 US dollar ~ 7.8 Hong Kong dollar) per month

154   (Table 1), and had chronic health conditions (Table 3) were more likely to rate their OH poorly.

155

156   After adjusting for age and sex, and further adjustment on education, income, health behaviors,

157   BMI, blood pressures, and social desirability, the association between SROH and chronic health

158   conditions still existed (Table 4). The three sets of models yielded similar odds ratios. Among all

159   chronic health conditions, nervous system disease has the strongest association with self-reported

160   OH. Those having bad / very bad SROH were associated with an adjusted odds ratio of 3.30

161   times ($p < 0.001$) of self-reported nervous system disease compare with those with very good /

162   good / average SROH, while the adjusted odds ratios on other chronic health conditions ranged

163   from 1.13 (high cholesterol, $p = 0.033$) to 1.73 (stomach / intestinal disease, $p < 0.001$).

164

165   **DISCUSSION**

166   As a large scale epidemiological study of SROH, this study may help expand our understanding

167   of the relationship between OH and general health and may suggest new directions for future

168   research and OH policies. Significant associations found in this study are important as they may

169   lead to design and testing of intervention programs on both preventing oral diseases and

170   promoting healthy oral habits to those having the aforementioned conditions, and on preventing

171   chronic diseases in those with poor oral health. In assessing OH, this study relied on global

172   ratings of SROH. Despite the rather simplistic nature of global SROH ratings, they are powerful

173   assessment tools and have been shown to be associated with clinical OH attributes and subjective

174   perceptions (15). Global rating of general health has been shown to be associated with self-

175   reports of systemic diseases and other health problems (16). Having indentified association

176   between SROH and general health status, further exploration of the clinical OH features in

177   pathways and mechanisms of their association may be useful.

178

179   Consistent with the past studies, this study confirms that demographic factors have a strong

180   association with both SROH (17-19) and chronic health conditions (20) in the population. Socio-

181   demographics are recognized as key determinants of SROH and chronic health conditions, but as

182   our results were cross-sectional, the causal relationship is yet to clarified, that is, whether socio-

183   demographic disadvantage gives rise to poor general health or poor general health leads to such

184   disadvantage remains unclear. Past studies also showed a relationship between low socio-

185 economic status and higher glucose intolerance in Hong Kong (21). This question is important to

186 consider in addressing social inequalities in oral health (22). The use of lifecourse epidemiology

187 studies should be useful in explaining the trajectory of socio-demographics and poor SROH and

188 its interplay/ mediation with poor general health. As the most westernized and urbanized city in

189 China, Hong Kong has an extensive and efficient public health care system similar to the UK

190 National Health Service (23), we believe our findings in Hong Kong could be generalized to

191 other Western countries and can forewarn the future problems of health and diseases in China

192 Mainland which is developing rapidly.

193

194 Bivariate analyses identified cross-sectional association with SROH on all of the general health

195 problems, and for all conditions this remained significant after controlling for demographics. It is

196 not too surprising to note the association between poor SROH and diabetes, as there are many

197 such reports in the literature (3). Indeed, interdisciplinary collaboration between dentistry and

198 endocrinology has expanded in recent years for the screening of diabetes and OH problems, as

199 well as mutual advocacy for dental care in glycaemic control (6). Likewise the association

200 between poor SROH and musculoskeletal problems could be anticipated, and this lends support

201 to the growing body of reports on the relationship between OH and common musculoskeletal

202 problems such as osteoporosis (24).

203

204 Interestingly is the observed cross-sectional association between poor SROH with ENT and

205 stomach/digestion problems; in part because of the obvious anatomical proximity and potential

206 consideration in differential diagnoses of both health problems, and yet there is little about such

207 issue in the literature. Also the observed cross-sectional association between poor SROH and

208   thyroid problems, as well as with neurological conditions, provides a further expansion into the

209   likely multiple interrelationships with SROH and general health that warrants further attention.

210   Given the key aetiological factors of poor SROH are diet, hygiene, and smoking – and these too

211   are central to many general health problems, a multi-sector, common risk factor approach to

212   address them seems prudent (25).

213

214   The weak but significant cross-sectional association for cholesterol and blood pressure in our

215   study (odds ratio = 1.1) worth particular attention as a recent U.S. population-based survey

216   showed that metabolic syndrome was moderately associated with severe periodontitis (26). This

217   weak association suggests further studies on SROH and clinically observed factors, such as

218   lipoprotein levels, are warranted.

219

220   The major limitation is the cross-sectional nature of the study. The associations found in this

221   research may not imply causality, for example poor general health may reduce psychological

222   well-being and cause symptoms of depression, which may lead to smoking and drinking.

223   Nonetheless, our results warranted further prospective studies and randomized controlled trials to

224   confirm whether the association is causal and whether improving OH can improve general health.

225   The co-morbidity shown between OH and general health, although adjusted for socio-

226   demographic variables, may be inflated as there are other common risk factors for OH and

227   general health. Another limitation is that self-selection bias might exist because every member in

228   a household had to participate in order to be eligible. Nonetheless, given the representativeness

229   of our sample (10), the study benefits from being a large population based study of SROH and

230   multiple health problems and our results are unique among Chinese population studies.   Lastly,

231 the chronic health conditions were all self-reported, since it was not feasible to examine

232 clinically such a large group of participants during the household interview. Nonetheless, face

233 validity was examined through agreement with medicine usage, so this limitation should not

234 affect our results substantially.

235

236 To conclude, this study has identified cross-sectional associations of SROH with chronic health

237 conditions including cancer, DM, high blood pressure, high cholesterol, thyroid disease, nervous

238 system disease, ENT disease, stomach / intestinal disease, and musculoskeletal disease. Further

239 studies on the underlying pathological mechanisms behind the associations between OH and

240 general health (for instance, whether the treatment of oral health diseases could lead to better

241 general health) and the trajectory and pathway of the relationships over time are encouraged.

242 Both dental and general health care professionals should be aware of such associations in

243 addressing health problems of the community.

244

251

252 **CONFLICTS OF INTEREST**

253 The authors declared no conflict of interest.

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Table 1. Relationship between self-reported oral health and demographics in the FAMILY project cohort study, 2009-2011

Self-reported Oral health	Frequency	Age [a]	Male[b]	Tertiary educated[b]	Income >20000[b,c]	Current smoker[b]	Excess drinker[b,d]	Obese[b,e]
Very good	501	40.32	215 (42.9%)	80 (16.0%)	93 (18.6%)	69 (13.8%)	21 (4.2%)	136 (27.4%)
Good	14,020	43.98	6,053 (43.2%)	1,805 (12.9%)	1,990 (14.2%)	1,865 (13.3%)	293 (2.1%)	4,041 (29.1%)
Average	21,849	43.15	10,387 (47.5%)	2,178 (11.4%)	2,483 (11.4%)	3,757 (17.2%)	572 (2.6%)	6,669 (30.8%)
Bad	4,801	50.32	2,363 (49.2%)	304 (6.3%)	392 (8.2%)	1,005 (20.9%)	158 (3.3%)	1,633 (34.3%)
Very bad	470	52.95	220 (46.8%)	34 (7.2%)	29 (6.2%)	116 (24.7%)	23 (4.9%)	143 (31.0%)
Overall	41,641	44.44	19,238 (46.2%)	4,401 (10.6%)	4,987 (12.0%)	6,812 (16.4%)	1,067 (2.6%)	12,622 (30.6%)
p		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
p for trend		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Data are reported in frequencies (row percentage) of participants within each oral health status group, except for age.

[a] p-value of one way analysis of variance (ANOVA).

[b] p-value of χ^2 test.

[c] Personal income per month in Hong Kong dollar (1 US dollar ~ 7.8 Hong Kong dollar).

[d] Consume at least 210 g (male) / 140 g (female) of alcohol per week.

[e] BMI ≥ 25.

15

333 Table 2. Relationship between chronic health conditions and demographics in the FAMILY project cohort study,
334 2009-2011
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Self-reported Oral health	Age [a]	Male[b]	Tertiary educated[b]	Income >20000[b,c]	Current smoker[b]	Excess drinker[b,d]	Obese[b,e]
Cancer							
Yes	58.53	209 (39.5%)	30 (5.7%)	32 (6.0%)	61 (11.5%)	16 (3.0%)	167 (32.1%)
No	44.37	19,028 (46.3%)	4,372 (10.6%)	4,954 (12.1%)	6,751 (16.4%)	1,052 (2.6%)	12,454 (30.5%)
Diabetes mellitus							
Yes	63.15	1,094 (48.1%)	93 (4.1%)	136 (6.0%)	311 (13.7%)	44 (1.9%)	1,136 (50.3%)
No	43.47	18,143 (46.1%)	4308 (10.9%)	4,850 (12.3%)	6,502 (16.5%)	1,024 (2.6%)	11,485 (29.4%)
High blood pressure							
Yes	64.22	2,613 (45.7%)	261 (4.6%)	373 (6.5%)	689 (12.1%)	139 (2.4%)	2,998 (53.0%)
No	41.42	16,625 (46.3%)	4,141 (11.5%)	4,614 (12.9%)	6,124 (17.1%)	929 (2.6%)	9,623 (27.0%)
High cholesterol							
Yes	58.88	1,290 (45.4%)	295 (10.4%)	429 (15.1%)	344 (12.1%)	56 (2.0%)	1,375 (48.8%)
No	43.50	17,948 (46.3%)	4,106 (10.6%)	4,557 (11.8%)	6,469 (16.7%)	1,012 (2.6%)	11,246 (29.2%)
Thyroid disease							
Yes	50.29	187 (19.1%)	88 (9.0%)	99 (10.1%)	108 (11.1%)	19 (1.9%)	309 (31.9%)
No	44.41	19,050 (46.8%)	4,314 (10.6%)	4,887 (12.0%)	6,705 (16.5%)	1,049 (2.6%)	12,312 (30.5%)
Nervous system disease							
Yes	52.77	75 (44.4%)	16 (9.4%)	11 (6.5%)	11 (6.5%)	4 (2.4%)	56 (33.9%)
No	44.52	19,162 (46.2%)	4,385 (10.6%)	4,976 (12.0%)	6,801 (16.4%)	1,063 (2.6%)	12,565 (30.6%)
ENT disease							
Yes	49.51	2,528 (44.9%)	615 (10.9%)	678 (12.0%)	829 (14.7%)	147 (2.6%)	1,722 (30.8%)
No	43.77	16,709 (46.4%)	3,786 (10.5%)	4,308 (12.0%)	5,984 (16.6%)	921 (2.6%)	10,899 (30.5%)
Stomach / intestinal disease							
Yes	49.81	419 (45.6%)	106 (11.5%)	150 (16.3%)	169 (18.4%)	33 (3.6%)	267 (29.2%)
No	44.43	18,819 (46.2%)	4,295 (10.5%)	4,837 (11.9%)	6,644 (16.3%)	1,035 (2.5%)	12,354 (30.6%)
Musculoskeletal disease							
Yes	57.51	1,296 (39.3%)	254 (7.7%)	359 (10.9%)	455 (13.8%)	96 (2.9%)	1,395 (42.8%)
No	43.44	17,942 (46.8%)	4,148 (10.8%)	4,627 (12.1%)	6,358 (16.6%)	972 (2.5%)	11,226 (29.5%)
Overall	44.44	19,238 (46.2%)	4,401 (10.6%)	4,987 (12.0%)	6,812 (16.4%)	1,067 (2.6%)	12,622 (30.6%)
p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
p for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

336 Data are reported in frequencies (row percentage) of participants within each oral health status group, except for
337 age.
338 [a] *p*-value of one way analysis of variance (ANOVA).
339 [b] *p*-value of χ^2 test.
340 [c] Personal income per month in Hong Kong dollar (1 US dollar ~ 7.8 Hong Kong dollar).
341 [d] Consume at least 210 g (male) / 140 g (female) of alcohol per week.
342 [e] BMI ≥25.
343

344 Table 3. Relationship between self-reported oral health and chronic health conditions

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Self-reported Oral health	Cancer	Diabetes mellitus	High blood pressure	High cholesterol	Thyroid disease	Nervous system disease	ENT disease	Stomach / intestinal disease	Musculoskelet al disease
Very good	8 (1.6%)	15 (3.0%)	45 (9.0%)	35 (7.0%)	12 (2.4%)	0 (0.0%)	57 (11.4%)	18 (3.6%)	34 (6.8%)
Good	164 (1.2%)	606 (4.3%)	1,611 (11.5%)	845 (6.0%)	296 (2.1%)	34 (0.2%)	1,630 (11.6%)	242 (1.7%)	885 (6.3%)
Average	233 (1.1%)	1,171 (5.4%)	2,961 (13.6%)	1,454 (6.7%)	479 (2.2%)	78 (0.4%)	2,883 (13.2%)	457 (2.1%)	1,653 (7.6%)
Bad	109 (2.3%)	433 (9.0%)	990 (20.6%)	447 (9.3%)	178 (3.7%)	47 (1.0%)	949 (19.8%)	174 (3.6%)	651 (13.6%)
Very bad	16 (3.4%)	49 (10.4%)	107 (22.8%)	58 (12.3%)	12 (2.5%)	11 (2.3%)	115 (24.5%)	28 (6.0%)	72 (19.9%)
Overall	530 (1.3%)	2,274 (5.5%)	5,714 (13.7%)	2,839 (6.8%)	977 (2.3%)	170 (0.4%)	5,634 (13.5%)	919 (2.2%)	3,295 (7.9%)
p [a]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
p for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

346 ENT: Ear / Nose / Throat

347 Data are reported in frequencies (row percentage) of participants within each oral health status group.

348 [a] p-value of χ^2 test.

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350 Table 4. Relationship between self-reported bad/very bad oral health and chronic health conditions
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Chronic health conditions	OR 1 [a]	95% CI	OR 2 [b]	95% CI	OR 3 [c]	95% CI
Cancer	1.59***	(1.29, 1.95)	1.58***	(1.27, 1.96)	1.55***	(1.25,1.93)
Diabetes mellitus	1.28***	(1.15, 1.43)	1.25***	(1.12, 1.41)	1.25***	(1.11, 1.40)
High blood pressure	1.10*	(1.01, 1.20)	1.14**	(1.04, 1.26)	1.14**	(1.04, 1.25)
High cholesterol	1.09	(0.98, 1.21)	1.15*	(1.03, 1.28)	1.13*	(1.01, 1.26)
Thyroid disease	1.53***	(1.30, 1.80)	1.59***	(1.34, 1.89)	1.54***	(1.30, 1.83)
Nervous system disease	3.03***	(2.19, 4.20)	3.34***	(2.34, 4.77)	3.30***	(2.31, 4.72)
ENT disease	1.56***	(1.45, 1.68)	1.57***	(1.45, 1.70)	1.51***	(1.39, 1.64)
Stomach / intestinal disease	1.77***	(1.51, 2.08)	1.79***	(1.51, 2.12)	1.73***	(1.46, 2.05)
Musculoskeletal disease	1.57***	(1.43, 1.72)	1.61***	(1.46, 1.77)	1.55***	(1.41, 1.71)

352 CI: confidence interval, ENT: Ear / Nose / Throat
353 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
354 [a] Odds ratio of bad / very bad self-reported oral health on the corresponding chronic health condition adjusting
355 for age and sex.
356 [b] Odds ratio of bad / very bad self-reported oral health on the corresponding chronic health condition adjusting
357 for age, sex, education, income, health behaviors, BMI, and blood pressures.
358 [c] Odds ratio of bad / very bad self-reported oral health on the corresponding chronic health condition adjusting
359 for age, sex, education, income, health behaviors, BMI, blood pressures, and social desirability.
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