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The effect of health insurance coverage on antenatal care utilization in Cambodia: A secondary analysis of Cambodia Demographic and Health Survey 2021-2022

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Abstract

Health insurance is essential in reducing or eliminating the financial constraint to accessing maternal health services caused by out-of-pocket payments. Also, it has a beneficial effect in minimizing the number of maternal and child mortality. However, limited studies in Cambodia examined the association between health insurance coverage on antenatal care (ANC) utilization. Therefore, this study examined the effect of health insurance coverage on ANC utilization in Cambodia. The study utilized data from the 2021-2022 Cambodia Demographic and Health Surveys (CDHS). A total of 3,162 weighted women who gave birth within two years were included in the study. Multiple logistic regression analysis was explored to assess the association between health insurance coverage on women who attended four or more ANC visits. About 24.9% of the women had health insurance coverage during 2021-2022. Most (86.1%) of women attended four or more ANC visits. Women with health insurance coverage were statistically significantly associated with attending four or more ANC visits with an adjusted odds ratio (AOR = 1.6; 95% CI: 1.1–2.4). Other covariates significantly associated with women who attended four or more ANC visits include women with higher education (AOR = 3.1; 95% CI: 1.2–7.7), secondary education (AOR = 2.3; 95% CI: 1.5–3.5), richest households (AOR = 3.2; 95% CI: 1.5-6.8), and richer households (AOR = 1.9; 95% CI: 1.2-2.8). Pregnant women with health insurance coverage, who had completed at least secondary education and had a better wealth index were more likely to attend at least four ANC visits. Thus, improving health insurance coverage, and women's economic and education may be essential to improving women's access to attended ANC utilization services in Cambodia.

Key work: Health insurance, Antenatal care utilization, Pregnant women, Cambodia

36 **Introduction**

37

38 Cambodia's maternal mortality rate has significantly declined in the past decade. Data from the
39 2021-2022 Cambodia Demographic and Health Surveys (CDHS) show that maternal mortality had
40 declined dramatically, from 488 to 154 per 100,000 live births between 2000 and 2021-2022 [1,2].
41 By 2030, the global maternal death ratio is expected to drop to less than 70 per 100,000 live births,
42 according to Sustainable Development Goal (SDG) 3.1[3]. This achievement can be attributed to
43 the country's concerted effort to increase women's access to maternal health services, particularly
44 the initiative to increase institutional births [4]. Institutional births dramatically increased, from
45 19.3% to 98%, while the proportion of pregnant women attending four or more antenatal care
46 (ANC) appointments increased considerably, from 9% to 86.1%, between 2000 and 2021-2022 [5].
47 In several studies, women who had health insurance had higher rates of using maternal health
48 treatments, such as timely ANC and attending four or more ANC visits [6-9].

49

50 In 2019, the total population of Cambodia was 15.55 million, with 17.8% living below the national
51 poverty line [10]. Since 2016, Cambodia has been classified as a lower-middle-income country,
52 with gross domestic product (GDP) per capita from 302 US dollars in 2000 to 1,625 US dollars in
53 2021 [11]. Also, current expenditures on health per capita significantly increased from 20 US
54 dollars in 2000 to 116 US dollars in 2020 [12]. Globally, 50% of people cannot access essential
55 health services, as the World Bank and World Health Organization (WHO) reported in 2017 [13].

56

57 Cambodian National Social Security Fund (NSSF) has provided health insurance coverage to
58 formal sector workers [14]. And poor households are covered by the Health Equity Fund (HEF),
59 the co-financing mechanism of the government and development partners [15]. By 2025, the
60 government intends to expand the reach of the NSSF health insurance program to include the entire
61 population [16]. Data from CDHS 2021-2022 indicated that 22% of women and 13% of men aged
62 15-49 years have any health insurance, respectively [5]. Health insurance coverage is expected to
63 provide financial risk protection and reduce disparities in access by facilitating greater uptake of
64 maternal health services [13]. To our knowledge, limited published peer-reviewed studies assess
65 the association between health insurance coverage and access to maternal health services among
66 women of reproductive age in Cambodia using updated data. One prior study on health insurance

67 coverage and its impact on maternal healthcare utilization in low- and middle-income countries
68 utilized data from CDHS 2010 [8]. This study included all women and men aged 15-49 and pooled
69 Demographic and Health Survey (DHS) data in 30 low-and middle-income countries (LMICs) [8].
70 An additional study aimed to assess levels of health insurance coverage in 30 LMICs and examines
71 the impact of health insurance status on the use of maternal health care in eight countries spanning
72 sub-Saharan Africa (Burundi et al., Namibia, and Rwanda), West Asia (Albania), and South and
73 Southeast Asia (Cambodia and Indonesia) [8]. Several pieces of evidence on the effect of health
74 insurance coverage on ANC utilization have been published [6-9,17-19]; results indicate that
75 women with health insurance coverage had higher odds attended four or more ANC visits than
76 those without [6-9,17-19]. Moreover, those women who reported exposure to media, married
77 women, those with high education, those living in wealthy economic families, those who are
78 unemployed, and those living in urban areas were also factors associated with attending four or
79 more ANC visits [6-9,17-19]. Given the lack of scholarship addressing this health concern among
80 Cambodian women aged 15-49, we examined the effects of health insurance coverage on antenatal
81 care (ANC) utilization among women who had a live birth in the past two years in Cambodia. The
82 findings will provide a broader perspective on levels of health insurance coverage and the impact
83 of health insurance status on the use of maternal health care in Cambodia. Additionally, the study
84 will enable policymakers to understand better health insurance coverage among the adult
85 population in Cambodia and proffer suggestions for improving universal health coverage in
86 Cambodia.

87

88 **Material and Methods**

89

90 **Ethical statement**

91

92 The CDHS 2021–2022 is publicly available, with all personal identifiers of study participants
93 removed. Permission to analyze the data was granted by registering with the DHS program website
94 at (URL: <https://dhsprogram.com/data/available-datasets.cfm>). Written informed consent was
95 obtained from the parent/guardian of each participant under 18 before data collection. The
96 Cambodia National Ethics Committee for Human Health Research (NECHR) approved the data
97 collection tools and procedures for CHDS 2021-2022 for Health Research on 10 May 2021

98 (Reference number: 83 NECHR) and ICF's Institutional Review Board (IRB) in Rockville,
99 Maryland, USA.

100

101 **Data source**

102

103 We used data from the most recent CDHS (2021–2022), a household survey conducted every five
104 years nationally representative of the population [5]. The two-stage stratified cluster sampling
105 method collected the samples from all provinces. At the first stage, clusters, or enumeration areas
106 (EAs), that represent the entire country (urban and rural), are randomly selected from the sampling
107 frame using probability proportional (PPS) to cluster size. In the second stage, a complete listing
108 of households was selected from each cluster using an equal probability systematic sampling, and
109 then interviews were conducted with women aged 15–49 years who were born in the five years
110 preceding the survey in the complete list selected households [5]. In total, 19,496 women aged 15-
111 49 who had given birth in the last five years were interviewed face-to-face, using the survey
112 standard questionnaire to collect information from women on several health indicators such as
113 maternal health care service utilization, maternal and child health, nutrition, and reproductive
114 health services [5]. Overall, 15,046 women who had not given birth in the past two years were
115 excluded. Data restriction resulted in women who had a live birth in the past two years in a final
116 analytic sample of 3,292 women (3,162 weighted women).

117

118 **Measurements**

119

120 **Outcome variable**

121

122 This study's outcome was the number of ANC visits during the last pregnancy among women aged
123 15-49 years (coded as 0 = less than 4 ANC visits included women who reported no ANC visits and
124 1 = four or more ANC visits) [6,18,20].

125

126 **Independent variables**

127

128 The primary independent variable is maternal health insurance coverage (coded as 0=no (reference
129 and 1=yes), including public and private insurance. The confounding variables included maternal
130 factors: Women's age in years (coded as 1=15-30 (reference) and 2=31-49), marital status (coded
131 as 1=married (reference) and 2=not married), birth order (coded as 1=1 (reference), 2=2-3, and

132 3=4 or more), education (coded as 0 = no education (reference), 1=primary, and 2=secondary or
133 higher), occupation (coded as 0=not working (reference), 1=professional, 2=sales or services,
134 3=agricultural, and 4=manual labor). Individual Household factors included the household wealth
135 index (coded as 1=poorest (reference), 2=poorest, 3=medium, 4=richer, and 5=richest) were
136 calculated following the principal component analysis (PCA) [5]. Cambodia's geographical
137 regions were grouped into four categories (coded as 1=Plains (reference), 2=Tonle Sap,
138 3=Coastal/Sea, and 4=Mountains), and place of residences (coded as 1=urban (reference) and
139 2=rural) was defined based on Cambodia's General Population Census 2019 and adapted from the
140 original CDHS 2021-2022 [5,10].

141

142 **Statistical analysis**

143

144 Statistical analysis was performed using STATA version 17 (StataCorp LLC). We applied for the
145 DHS standard sampling weight variable (**v005/1,000,000**). Then, we used the survey-specific
146 STATA command "**svy**" for descriptive and analytical analysis. Women's socio-economic and
147 demographic characteristics were described using weighted frequency and percentage
148 distributions.

149 Bivariate analysis using Chi-square tests assessed the association between the variables of interest
150 (maternal and individual household characteristics) and ANC visits. All independent variables
151 associated with ANC use at p-value ≤ 0.10 , or that had a potential confounder variable [6,18] were
152 included in the multiple logistic regression analysis to determine the independent factors related
153 to ANC use [26]. Multicollinearity between original independent variables was checked, including
154 women's age, number of children ever born, education, wealth index, occupation, marital status,
155 coverage health insurance, and place of residence. The result of the evaluating variance inflation
156 factor (VIF) scores after fitting an Ordinary Least Squares regression model with the mean value
157 of VIF was 1.53, which is less than the cutoff point indicating no collinearity correlation among
158 the independent variables [27].

159

160 **Results**

161

162 **Characteristics of the study population**

163

164 **Table 1** describes the socio-economic and demographic characteristics of the 3,162 women aged
 165 15–49 born in the last two years preceding the survey. The mean age was 22.2 years old (SD = 4.2
 166 years); the age group of 15–29 years old accounted for 94.3%. The majority (95%) were currently
 167 married. More than 33.4% of women had their first child. Half of the women completed at least
 168 secondary education, while 10.6% had no formal education. Only 6.5% of workers were
 169 professionals, and 31.2% were unemployed. Of the sample, 20.7% of women were from the
 170 poorest households, and 19.7% were from poorer households. Sixty-two percent of the women
 171 lived in rural areas. Only 786 (24.9%) women aged 15–49 had health insurance coverage. 86.1%
 172 of women attended at least four ANC visits during pregnancy.

173

174 **Table 1.** Socio-economic and demographic characteristics of women aged 15-49 years with a birth in the
 175 last two years preceding the survey (N = 3,162 weighted)
 176

Variables	Freq.	%
Mean age at the time of birth (SD)	22.2(4.2)	
15-29	2,982	94.3
30-49	180	5.7
Marital status		
Married	3,004	95.0
Not married	158	5.0
Birth order		
1 child	1055	33.4
2-3 children	1197	37.9
4 or more children	909	28.7
Educational		
No education	334	10.6
Primary	1253	39.6
Secondary	1361	43.0
Higher	214	6.8
Occupation		
Not working	986	31.2
Professional	205	6.5
Sales	579	18.3
Agricultural	445	14.1
Services	76	2.4
Manual labor	810	25.6
Wealth index		
Poorest	655	20.7

Poorer	623	19.7
Middle	626	19.8
Richer	683	21.6
Richest	574	18.2
Residence		
Urban	1202	38.0
Rural	1960	62.0
Region		
Plain	1532	48.5
Tonle Sap	996	31.5
Coastal	201	6.4
Plateau/Mountain	432	13.7
Covered by health insurance		
No	2376	75.1
Yes	786	24.9
Number of ANC visits		
< 4 ANC	440	13.9
≥ 4 ANC	2722	86.1

Notes: Survey weights are applied to obtain weighted percentages. ***Plains:** Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; **Tonle Sap:** Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; **Coastal/sea:** Kampot, Kep, Preah Sihanouk, and Koh Kong; **Mountains:** Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

Factors Associated with Four or more ANC visits in Chi-Square analysis

In bivariate analysis (**Table 3**), a higher proportion of women with health insurance coverage had a significant association with four or more ANC visits (91.6% vs. 84.2%, $p < 0.001$). Women aged 31–49 reported being more likely to attend four or more ANC visits (88.0% vs. 86.0%, $p < 0.001$). Also, married women reported four or more ANC visits than nonmarried women (86.6% vs. 76.2%, $p = 0.007$). Women with no education were less likely to attend four or more ANC visits than those with higher education (71.0% vs. 95.6%, $p < 0.001$). Four or more ANC visits were higher among women working in professional (95.3%) and service (96.4%), respectively, compared to unemployed women (84.3), with $p < 0.001$. Additionally, four or more ANC visits were higher among women from the richer and richest on the wealth index (94.8 and 89.4%, respectively), compared to the poorer and poorest (73.9 and 86.9%, respectively, with $p < 0.001$). Lastly, women living in urban areas reported higher four or more ANC visits than in rural areas (91.5 vs. 82.7%, $p < 0.001$).

Table 3. Maternal and household characteristics by women attending at least four antenatal care and delivery in a health facility (N = 3,162)

Variables	Number of ANC visits		p-value
	Four or more n=2,722	Less than four n=440	
	%	%	
Covered by health insurance			
No	84.2	15.8	<0.001
Yes	91.6	8.4	
Age at time of birth			
15-30	86.0	14.0	<0.001
31-49	88.0	12.0	
Marital status			
Married	86.6	13.4	0.007
Not married	76.2	23.8	
Birth order			
1 child	88.4	11.6	<0.001
2-3 children	88.6	11.4	
4 or more children	80.1	19.9	
Educational			
No education	71.0	29.0	<0.001
Primary	84.1	15.9	
Secondary	90.1	9.9	
Higher	95.6	4.4	
Occupation			
Not working	84.3	15.7	<0.001
Professional	95.3	4.7	
Sales	84.4	15.6	
Agricultural	79.0	21.0	
Services	96.4	3.6	
Manual labor	89.9	10.1	
Wealth index			
Poorest	73.9	26.1	<0.001
Poorer	86.9	13.1	
Middle	86.3	13.7	
Richer	89.4	10.6	
Richest	94.8	5.2	
Residence			
Urban	91.5	8.5	<0.001
Rural	82.7	17.3	
Region			
Plain	89.3	10.7	<0.001
Tonle Sap	86.6	13.4	
Coastal	89.0	11.0	
Plateau/Mountain	72.2	27.8	

Notes: Survey weights are applied to obtain weighted percentages. ***Plains:** Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; **Tonle Sap:** Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; **Coastal/sea:** Kampot, Kep, Preah Sihanouk, and Koh Kong; **Mountains:** Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

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211 **Association between health insurance and maternal Healthcare Services Utilization**

212

213 **Table 4** shows the results of the multiple logistic regression analysis of the association between

214 health insurance coverage and maternal healthcare services utilization after controlling for the

215 socio-demographic factors. Compared to women without health insurance, those with health

216 insurance coverage were more likely to attend four or more ANC visits (AOR = 1.6, 95% CI: 1.1–

217 2.4). Women with higher education (AOR = 3.1, 95% CI: 1.2–7.7), secondary education (AOR =

218 2.3, 95% CI: 1.5–3.5), and primary education (AOR = 1.7, 95% CI: 1.2–2.7) were more likely to

219 have four or more ANC visits than women without any formal education. The odds of having four

220 or more ANC visits were more significant for women from the wealthiest households than for

221 those from the poorest households: richest households (AOR = 3.2; 95% CI: 1.5-6.8), richer

222 households (AOR = 1.9; 95% CI: 1.2-2.8), and middle households (AOR = 1.5; 95% CI: 1.1-2.2).

223 However, the odds of having four or more ANC visits were lower in unmarried women than in

224 married women (AOR = 0.5; 95% CI: 0.3-0.8).

225

226 **Table 4.** Association between health insurance and four or more ANC visits in simple and multiple logistic

227 regression model (N = 3,162)

Variables	Four or more ANC visits			
	Unadjusted		Adjusted	
	OR	95% CI	AOR	95% CI
Covered by health insurance				
No	Ref.		Ref.	
Yes	2.0***	(1.4-2.9)	1.6*	(1.1-2.4)
Age at time of birth				
15-30	Ref.		Ref.	
31-49	1.2	(0.7-2.1)	1.1	(0.6-2.0)
Marital status				
Married	Ref.		Ref.	
Not married	0.5**	(0.3-0.8)	0.5**	(0.3-0.8)
Birth order				
1child	Ref.		Ref.	
2-3 children	1.0	(0.8-1.4)	1.1	(0.8-1.5)
4 or more children	0.5***	(0.4-0.7)	0.7*	(0.5-1.0)
Educational				
No education	Ref.		Ref.	
Primary	2.2***	(1.5-3.1)	1.8**	(1.2-2.7)
Secondary	3.7***	(2.6-5.3)	2.3***	(1.5-3.5)
Higher	8.9***	(4.3-18.3)	3.1*	(1.2-7.7)
Occupation				
Not working	Ref.		Ref.	
Professional	3.8***	(2.0-7.0)	1.4	(0.7-2.8)

Sales	1.0	(0.7-1.4)	0.7	(0.5-1.0)
Agricultural	0.7*	(0.5-1.0)	1.0	(0.7-1.4)
Services	4.9**	(1.8-13.5)	2.6	(0.9-7.2)
Manual labor	1.7**	(1.2-2.3)	1.3	(0.9-1.9)
Wealth index				
Poorest	Ref.		Ref.	
Poorer	2.4***	(1.7-3.2)	1.7**	(1.2-2.3)
Middle	2.2***	(1.6-3.1)	1.5*	(1.1-2.2)
Richer	3.0***	(2.1-4.2)	1.9**	(1.2-2.8)
Richest	6.4***	(3.4-12.0)	3.2**	(1.5-6.8)
Residence				
Urban	Ref.		Ref.	
Rural	0.4***	(0.3-0.6)	0.8	(0.5-1.1)
Region				
Plain	Ref.		Ref.	
Tonle Sap	0.8	(0.6-1.1)	1.2	(0.9-1.7)
Coastal	1.0	(0.6-1.5)	1.3	(0.8-2.1)
Plateau/Mountain	0.3***	(0.2-0.4)	0.5***	(0.3-0.6)

Ref = reference value

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Survey weights are applied to obtain weighted percentages. ***Plains:** Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; **Tonle Sap:** Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; **Coastal/sea:** Kampot, Kep, Preah Sihanouk, and Koh Kong; **Mountains:** Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

Discussion

We analyzed the most recent 2021–2022 CDHS data to examine the relationship between health insurance coverage and receiving four or more ANC visits during pregnancy. Overall, 24.9% of women reported having health insurance coverage among women of reproductive age who gave birth within two years of the survey. This finding is slightly similar to lower-middle-income countries, where 27.3% of women had health insurance coverage [19]. This is higher than in low-income countries, where 7.9% of women have health insurance coverage [19]. However, lower than in upper-middle-income countries, 52.5% of women had health insurance coverage [19]. Since the formal launch of the Cambodia National Social Security Fund (NSSF) with the Health Insurance Scheme in 2008, the proportion of women with health insurance coverage has increased from 16% in 2014 to 22% in 2021–2022 [5]. This proportion exponentially increased due to the Royal Government of Cambodia’s implementation of the NSSF for all workers in the formal and informal sectors of the economy [10]. Moreover, it has plans to extend the healthcare benefits under the NSSF to the family members of the employees as well [16].

253 This study found that women with health insurance coverage were 1.6 times more likely to attend
254 four or more ANC visits during pregnancy. Previous studies documented the positive relationship
255 between health insurance and the number of ANC visits among women of reproductive age
256 [8,9,19]. Health insurance eliminates the financial barrier to accessing maternal health services
257 caused by out-of-pocket payments. It has a beneficial effect in reducing the number of low-birth-
258 weight babies born and child mortality [17,21]. The result is more equitable access to care,
259 potentially improving maternal health outcomes [9,19]. The MoH has since raised the minimum
260 standard for ANC visits during pregnancy to at least four trips [20,22]. The dramatically significant
261 increase in the highest prevalence of four or more ANC visits was an effort by the Royal
262 Government of Cambodia, which has strengthened health facilities across the country, particularly
263 in rural areas, improved infrastructure, provided essential medical equipment and supplies,
264 increased the number of midwives, expanded antenatal care, and provided more skilled medical
265 practitioners at childbirth to ensure safe delivery practices. Furthermore, to encourage early and
266 routine ANC visits, the government is offering pregnant women a monetary incentive of 20 US
267 dollars for each visit during a maximum of four ANC visits at any health facility with a contract
268 with the National Social Security Fund (NSSF) [14,23].

269
270 This study found that increased education and household wealth index increased the likelihood of
271 four or more ANC visits. Women's education and higher wealth index are more likely to attend
272 four or more ANC visits. This aligns with previous evidence around socio-economic inequalities
273 in maternal health service utilization in Cambodia and South Asia [24,25]. This may be because
274 the more educated women is the more aware of the importance of ANC for their health and baby
275 [26]. Additionally, education gives women the power to decide whether to seek medical attention
276 and enables them to recognize warning signs of pregnancy complications. Moreover, women from
277 higher-income households were more likely to be able to cover the costs of care-seeking, including
278 any related expenses and transportation [24,25]. Thus, in this study, women with higher education
279 levels and household wealth indexes had the highest proportion of health insurance coverage.

280
281 This study has several strengths. First, it used the most recent women's data from the 2021–2022
282 CDHS, an extensive representative national population-based household survey with a high
283 response rate of 97%. Second, the recall bias has been minimized by limited analysis of women's

284 most recent deliveries within the last two years preceding the survey [5]. Third, the complex survey
285 design and sampling weights in the analysis accounted for both descriptive and analytics methods
286 that enabled us to generalize our findings to the population of WRA in Cambodia. In addition,
287 DHS data were collected using validated survey methods and highly trained data collectors,
288 contributing to improved data quality [27]. Last, to our knowledge, this is the first study to report
289 the association between health insurance coverage and ANC visits in Cambodia. After controlling
290 sociodemographic factors, we found significant associations between health insurance coverage
291 and several forums or more ANC visits. A key finding compares the association with other studies
292 in Southeast Asia and globally.
293

294 Despite this, there are several limitations. First, this study used a secondary analysis, so it did not
295 address health institution factors of antenatal care utilization and service availability; hence, this
296 study could not explore the quality of ANC services, though the quality of healthcare services plays
297 a vital role in patient satisfaction and use. Second, the study's cross-sectional nature could not
298 assist in the temporal relationship of variables including the number of years since women joined
299 health insurance on ANC utilization. Therefore, further study should be conducted to identify
300 factors related to health institutions. In addition, antenatal care utilization should be performed
301 based on the new WHO guidelines revised in 2016 at the national level [22]. Moreover,
302 longitudinal studies that address comprehensive variables should be studied. Third, we excluded
303 other factors, such as maternal complications and women's empowerment indicators, that could
304 affect the use of maternal care. Lastly, CDHS did not assess a direct measure of maternal health
305 literacy.

306

307 **Conclusion**

308

309 This is the first study to report the association between health insurance coverage and ANC visits
310 in the healthcare setting in Cambodia. Cambodian pregnant women attend four or more antenatal
311 care visits, which is slightly high. However, it still needs to be satisfactory. Health among coverage
312 women of reproductive age in Cambodia is relatively low. Moreover, we found that women with
313 health insurance, women with education, and being rich in the wealth quintile were strong
314 predictors of women attending four or more ANC visits. There is a need to pay close attention to
315 improving the uptake of health insurance among women of reproductive age, especially targeting
316 women with no education, from low-income families, and women who reside in rural areas.
317 Policymakers may need to prioritize women of reproductive age in designing and implementing
318 health insurance programs to increase their uptake. This would provide financial risk protection,
319 facilitate access to maternal health services, and possible attainment of Cambodia's SDG 3 targets.

320

321 **Acknowledgments**

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323

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Supporting Information

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1 **The effect of health insurance coverage ~~and on~~ antenatal care utilization in Cambodia: A**
 2 **secondary analysis of Cambodia Demographic and Health Survey 2021-2022**

3
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12
 13 **Abstract**

14
 15 Health insurance is essential in reducing or eliminating the financial constraint to accessing
 16 maternal health services caused by out-of-pocket payments. ~~Also, it~~ has a beneficial effect in
 17 minimizing the number of maternal and child mortality. ~~However, limited studies in Cambodia~~
 18 ~~examined the association between health insurance coverage on antenatal care (ANC) utilization.~~
 19 ~~Therefore, this study was~~ We examined the ~~impact-effect~~ of health insurance coverage ~~and on~~
 20 ~~antenatal care (ANC) utilization in Cambodia. The study utilized~~ ~~We used~~ data from the 2021-
 21 ~~2022~~ Cambodia Demographic and Health Surveys (CDHS). A total of 3,162 weighted women who
 22 gave birth within two years were included in the study. ~~Multiple logistic regression analysis was~~
 23 ~~explored to assess t~~The association between health insurance coverage ~~and on with pregnant~~
 24 women who attended ~~at least four or more antenatal care~~ANC visits, ~~during their pregnancy was~~
 25 ~~evaluated using multiple logistic regression analysis.~~ About 24.9% of ~~the~~ women had health
 26 insurance coverage during 2021-~~2022~~. Most (86.1%) of women attended ~~at least four4 or more~~
 27 ANC visits. ~~Almost 91.6% of women participating in four or more ANC visits were covered by~~
 28 ~~health insurance. Women with Having~~ health insurance ~~coverage and attending four or more ANC~~
 29 ~~visits~~ were statistically significantly ~~associated with women attending at least four or more ANC~~
 30 ~~visits with an~~ adjusted odds ratio (AOR = 1.6; 95% CI: 1.1–2.4). Other ~~covariates factors~~
 31 significantly associated ~~with women attended anee of at four~~ or more ANC visits include women
 32 with higher education (AOR = 3.1; 95% CI: 1.2–7.7), secondary education (AOR = 2.3; 95% CI:
 33 1.5–3.5), richest households (AOR = 3.2; 95% CI: 1.5-6.8), and richer households (AOR = 1.9;95%
 34 CI: 1.2-2.8). Pregnant women with health insurance ~~coverage, who had completed at least~~
 35 ~~secondary education and had a better wealth index~~ were more likely to attend at least four ANC

36 visits. Thus, ~~improving providing~~ health insurance ~~coverage~~, ~~women's economic and education~~
37 ~~may be essential to improving women's access to maternal health~~ ~~attended ANC utilization services~~
38 in Cambodia.

39

40 **Key work:** Health insurance, Antenatal care utilization, Pregnant women, Cambodia

41

42

43 **Introduction**

44

45 Cambodia's maternal mortality rate has significantly declined in the past decade. Data from the
46 2021-2022 Cambodia Demographic and Health Surveys (CDHS) show that maternal mortality had
47 declined dramatically, from 488 to 154 per 100,000 live births between 2000 and 2021-2022 [1,2].
48 By 2030, the global maternal death ratio is expected to drop to less than 70 per 100,000 live births,
49 according to Sustainable Development Goal (SDG) 3.1 [3]. This achievement can be attributed to
50 the country's concerted effort to increase women's access to maternal health services, particularly
51 the initiative to increase institutional births [4]. Institutional births dramatically increased, from
52 19.3% to 98%, while the proportion of pregnant women attending four or more antenatal care
53 (ANC) appointments increased considerably, from 9% to 86.1%, between 2000 and 2021-2022 [5].
54 In several studies, women who had health insurance had higher rates of using maternal health
55 treatments, such as timely ANC and attending four or more ANC visits [6-9].

56

57 In 2019, the total population of Cambodia was 15.55 million, with 17.8% living below the national
58 poverty line [10]. Since 2016, Cambodia has been classified as a lower-middle-income country,
59 with gross domestic product (GDP) per capita from 302 US dollars in 2000 to 1,625 US dollars in
60 2021 [11]. Also, current expenditures on health per capita significantly increased from 20 US
61 dollars in 2000 to 116 US dollars in 2020 [12]. Globally, 50% of people cannot access essential
62 health services, as the World Bank and World Health Organization (WHO) reported in 2017 [13].

63

64 Cambodian National Social Security Fund (NSSF) has provided health insurance coverage to
65 formal sector workers [14]. And poor households are covered by the Health Equity Fund (HEF),
66 the co-financing mechanism of the government and development partners [15]. By 2025, the
67 government intends to expand the reach of the NSSF health insurance program to include the entire

68 population [16]. [Data from CDHS 2021-2022 indicated that 22% of women and 13% of men aged](#)
69 [15-49 years have any health insurance, respectively](#). ~~Thus, nearly 70% of the population aged 15-~~
70 ~~49 reported not covered by health insurance~~ [5]. Health insurance coverage is expected to provide
71 financial risk protection and reduce disparities in access by facilitating greater uptake of maternal
72 health services [13]. To our knowledge, limited published peer-reviewed studies assess the
73 association between health insurance coverage and access to maternal health services among
74 women of reproductive age in Cambodia using updated data. One prior study on health insurance
75 coverage and its impact on maternal healthcare utilization in low- and middle-income countries
76 utilized data from CDHS 2010 [8]. This study included all women and men aged 15-49 and pooled
77 Demographic and Health Survey (DHS) data in 30 low-and middle-income countries (LMICs) [8].
78 An additional study aimed to assess levels of health insurance coverage in 30 LMICs and examines
79 the impact of health insurance status on the use of maternal health care in eight countries spanning
80 sub-Saharan Africa (Burundi et al., Namibia, and Rwanda), West Asia (Albania), and South and
81 Southeast Asia (Cambodia and Indonesia) [8]. [Several pieces of evidence on the effect of health](#)
82 [insurance coverage on ANC utilization have been published](#) [6-9,17-19]; [results indicate that](#)
83 [women with health insurance coverage had higher odds attended four or more ANC visits than](#)
84 [those without](#) [6-9,17-19]. Moreover, [those women who reported exposure to media, married](#)
85 [women, those with high education, those living in wealthy economic families, those who are](#)
86 [unemployed, and those living in urban areas were also factors associated with attending four or](#)
87 [more ANC visits](#) [6-9,17-19]. Given the lack of scholarship addressing this health concern among
88 Cambodian women aged 15-49, we examined the effects of health insurance coverage ~~and on~~
89 ~~antenatal care (ANC)~~ utilization among ~~pregnant~~ women [who had a live birth in the past two years](#)
90 in Cambodia. The findings will provide a broader perspective on levels of health insurance
91 coverage and the impact of health insurance status on the use of maternal health care in Cambodia.
92 Additionally, the study will enable policymakers to understand better health insurance coverage
93 among the adult population in Cambodia and proffer suggestions for improving universal health
94 coverage in Cambodia.

95

96 **Material and Methods**

97

98 **Ethical statement**

99

100 The CDHS 2021–2022 is publicly available, with all personal identifiers of study participants
101 removed. Permission to analyze the data was granted by registering with the DHS program website
102 at (URL: <https://dhsprogram.com/data/available-datasets.cfm>). Written informed consent was
103 obtained from the parent/guardian of each participant under 18 before data collection. The
104 Cambodia National Ethics Committee for Human Health Research (NECHR) approved the data
105 collection tools and procedures for CHDS 2021–2022 for Health Research on 10 May 2021
106 (Reference number: # 83 NECHR) and ICF's Institutional Review Board (IRB) in Rockville,
107 Maryland, USA.

108

109 **Data source**

110

111

112 We used data from the most recent CDHS (2021–2022), a household survey conducted every five
113 years nationally representative of the population [5]. The two-stage stratified cluster sampling
114 method collected the samples from all provinces. At the first stage, clusters, or enumeration areas
115 (EAs), that represent the entire country (urban and rural), are randomly selected from the sampling
116 frame using probability proportional (PPS) to cluster size. In the second stage, a complete listing
117 of households was selected from each cluster using an equal probability systematic sampling, and
118 then interviews were conducted with women aged 15–49 years who were born in the five years
119 preceding the survey in the complete list selected households [5]. In total, 19,496 women aged 15-
120 49 who had given birth in the last five years were interviewed face-to-face, using the survey
121 standard questionnaire to collect information from women on several health indicators such as
122 maternal health care service utilization, maternal and child health, nutrition, and reproductive
123 health services [5]. Overall, 15,046 women who had not given birth in the past two years were
124 excluded. Data restriction resulted in women who had a live birth in the past two years in a final
125 analytic sample of 3,292 women (3,162 weighted women).

126

127 **Measurements**

128

129 **Outcome variable**

130

131 This study's outcome was the number of ANC visits during the last pregnancy among women aged
132 15-49 years (coded as 0 = less than 4 ANC visits included women who reported no ANC visits
133 and 1 = four ~~or and~~ more ANC visits) [6,18,20].
134

135 **Independent variables**

136 The primary independent variable is maternal health insurance coverage (coded as 0=no (reference
137 and 1=yes-vs. no)), including public and private insurance. The confounding variables included
138 maternal factors: Women's age in years (coded as 1=15-30 (reference) and 2=31-49), mMarital
139 status (coded as 1=married (reference) and 2=not married), bBirth order (coded as 1=1
140 (reference), 2=2nd, 3rd, and 3=4th or more), eEducation (coded as 0 = no education (reference),
141 1=primary, and 2=secondary or higher), oOccupation (coded as 0=not working (reference),
142 1=professional, 2=sales, or services, 3=agricultural, and 4>manual labor); Individual Household
143 factors included the hHousehold wealth index (coded as 1=poorest (reference), 2=poorest,
144 3=medium, 4=richer, and 5=richest) were calculated following the principal component analysis
145 (PCA) [5]. Cambodia's gGeographical regions were grouped into four categories –(coded as
146 1=Plains (reference), 2=Tonle Sap, 3=Coastal/Sea, and 4=Mountains), and pPlace of rResidence
147 (coded as 1=urban (reference) and 2=rural) (rural vs. urban) based on Cambodia's
148 General Population Census 2019 and adapted from the original CDHS 2021-2022 [5,10].
149

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151 **Statistical analysis**

152
153 ~~Analyses~~ Statistical analysis ~~were was~~ performed using STATA V17 (StataCorp LLC). We applied
154 for the CDHS standard sampling weight variable (y005/1,000,000). Then, we used the survey-
155 specific STATA command "svy" for descriptive and analytical analysis. Women's socio-economic
156 and demographic characteristics were described using weighted frequency and percentage
157 distributions.

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158 Bivariate analysis using Chi-square tests assessed the association between the variables of interest
159 (maternal and individual household characteristics) and ANC use. All independent variables
160 associated with ANC use at p-value ≤ 0.10 , or that had a potential confounder variable [6,18] were
161 included in the multiple logistic regression analysis to determine the independent factors related
162 to ANC use [26]. Multicollinearity between original independent variables was checked, including

163 women's age, number of children ever born, education, wealth index, occupation, marital status,
164 coverage health insurance, and place of residence. ~~The r~~Result of the evaluating variance inflation
165 factor (VIF) scores after fitting an Ordinary Least Squares regression model ~~with- t~~The mean value
166 of VIF was 1.53, which is less than the cutoff point indicating no collinearity correlation among
167 the independent variables [27].

168

169 **Results**

170

171 **Characteristics of the study population**

172

173 **Table 1** describes the socio-economic and demographic characteristics of the 3,162 women aged 15–49
 174 born in the last two years preceding the survey. The mean age was 22.2 years old (SD = 4.2 years); the age
 175 group of 15–29 years old accounted for 94.3%. The majority (95%) were currently married. More than 33.4%
 176 of women were giving in had -the first birth-order child. Half of the women completed at least secondary
 177 education, while 10.6% had no formal education. Only 6.5% of workers were professionals, and 31.2%
 178 were unemployed. Of the sample, 20.7% of women were from the poorest households, and 19.7% were
 179 from poorer households/families. Sixty-two percent of the women lived in rural areas. Only 786 (24.9%)
 180 women aged 15–49 had health insurance coverage. 86.1% of women attended at least four 4-ANC visits
 181 during pregnancy.

182 **Table 1.** Socio-economic and demographic characteristics of women aged 15-49 years with a birth in the
 183 last two years preceding the survey (N = 3,162 weighted)

184

Variables	Freq.	%
Mean age at the time of birth (SD)	22.2(4.2)	
15-29	2,982	94.3
30-49	180	5.7
Marital status		
Married	3,004	95.0
Not married	158	5.0
Birth order		
1 st -child	1055	33.4
2-3 rd children	1197	37.9
4 th child or more -children	909	28.7
Educational		
No education	334	10.6
Primary	1253	39.6
Secondary	1361	43.0
Higher	214	6.8
Occupation		
Not working None	986	31.2
Professional	205	6.5
Sales	579	18.3
Agricultural	445	14.1
Services	76	2.4
Manual labor	810	25.6
Wealth index		
Poorest	655	20.7
Poorer	623	19.7
Middle	626	19.8

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Richer	683	21.6
Richest	574	18.2
Residence		
Urban	1202	38.0
Rural	1960	62.0
Region		
Plain	1532	48.5
Tonle Sap	996	31.5
Coastal	201	6.4
Plateau/Mountain	432	13.7
Covered by health insurance		
No	2376	75.1
Yes	786	24.9
Number of ANC visits		
< 4 ANC	440	13.9
≥ 4 ANC	2722	86.1

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Notes: Survey weights are applied to obtain weighted percentages. *Plains: Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; Tonle Sap: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; Coastal/sea: Kampot, Kep, Preah Sihanouk, and Koh Kong; Mountains: Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

Maternal health insurance characteristics

The highest proportion of women having health insurance was among those aged 15-30 years (25.3.4%, $p=0.094$); higher education (48.1%, $p<0.001$); worked in professional jobs (59.0%), manual labor (52.5%) with $p<0.001$; and women from the richer households (30.2%), richest households (32.2%) with $p<0.001$; and women in urban areas (35.9%, $p<0.001$); (see Table 2).

Table 2. Socio-economic and demographic characteristics by the health insurance coverage of women aged 15-49 years with a birth in the last two years preceding the survey (N=3,162)

Variables	Covered by health insurance				p-value
	No (N=2,367)		Yes (N=786)		
	Freq.	%	Freq.	%	
Age at time of birth					
15-30	2,229	74.7	753	25.3	0.094
31-49	147	81.7	33	18.3	
Marital status					
Married	2,260	75.2	744	24.8	0.757
Not married	116	73.4	42	26.6	
Birth order					
1 st child	778	73.7	277	26.3	0.035
2 nd or 3 rd child	876	73.2	321	26.8	
4 th child or more	722	79.4	188	20.7	
Educational					
No education	269	80.5	65	19.5	<0.001

Primary	950	75.8	304	24.3	
Secondary	1,046	76.9	315	23.1	
Higher	111	51.9	103	48.1	
Occupation					
None	892	90.5	93	9.4	<0.001
Professional	84	41.0	121	59.0	
Sales	514	88.8	65	11.2	
Agricultural	387	87.0	58	13.0	
Services	64	84.2	12	15.8	
Manual labor	385	47.5	425	52.5	
Wealth index					
Poorest	537	82.0	118	18.0	<0.001
Poorer	493	79.1	131	21.0	
Middle	479	76.5	147	23.5	
Richer	477	69.8	206	30.2	
Richest	389	67.8	185	32.2	
Residence					
Urban	770	64.1	432	35.9	<0.001
Rural	1,606	81.9	354	18.1	
Region					
Plain	1,119	73.0	413	27.0	0.019
Tonle Sap	781	78.4	216	21.7	
Coastal	167	83.1	34	16.9	
- Plateau/Mountain	309.0	71.5	123.0	28.5	-

Notes: Survey weights are applied to obtain weighted percentages. *Plains: Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; Tonle Sap: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Oddar Meanchey; Coastal/sea: Kampot, Kep, Preah Sihanouk, and Koh Kong; Mountains: Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

Formatted Table

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208 **Factors Associated with Four or more ANC visits in Chi-Square analysis**

209
210
211 In bivariate analysis (**Table 3**), a higher proportion of women with health insurance coverage had a
212 significant association with four or more ANC visits (91.6% vs. 84.2%, $p < 0.001$). Women aged 31–49
213 reported being more likely to attend four or more ANC visits (88.0% vs. 86.0%, $p < 0.001$). Also, married
214 women reported four or more ANC visits than nonmarried women (86.6% vs. 76.2%, $p = 0.007$). Women
215 with no education were less likely to attend four or more ANC visits than those with higher education (71.0%
216 vs. 95.6%, $p < 0.001$). Four or more ANC visits were higher among women working in professional (95.3%)
217 and service (96.4%), respectively, compared to unemployed women (84.3), with $p < 0.001$). Additionally,
218 four or more ANC visits were higher among women from the richer and richest on the wealth index (94.8
219 and 89.4%, respectively), compared to the poorer and poorest (73.9 and 86.9%, respectively, with $p < 0.001$).
220 Lastly, women living in urban areas reported higher four or more ANC visits than in rural areas (91.5 vs.
221 82.7%, $p < 0.001$).

222
223 **Table 3.** Maternal and household characteristics by women attending at least four antenatal care and delivery in
224 a health facility (N = 3,162)
225

Variables	Number of ANC visits		p-value
	Four or more n=2,722	Less than four n=440	
	%	%	
Covered by health insurance			
No	84.2	15.8	<0.001
Yes	91.6	8.4	
Age at time of birth			
15-30	86.0	14.0	<0.001
31-49	88.0	12.0	
Marital status			
Married	86.6	13.4	0.007
Not married	76.2	23.8	
Birth order			
1 st child	88.4	11.6	<0.001
2 nd - or -3 rd children	88.6	11.4	
4 th - child or more children	80.1	19.9	
Educational			
No education	71.0	29.0	<0.001
Primary	84.1	15.9	
Secondary	90.1	9.9	
Higher	95.6	4.4	
Occupation			
Not working	84.3	15.7	<0.001

Professional	95.3	4.7	
Sales	84.4	15.6	
Agricultural	79.0	21.0	
Services	96.4	3.6	
Manual labor	89.9	10.1	
Wealth index			
Poorest	73.9	26.1	<0.001
Poorer	86.9	13.1	
Middle	86.3	13.7	
Richer	89.4	10.6	
Richest	94.8	5.2	
Residence			
Urban	91.5	8.5	<0.001
Rural	82.7	17.3	
Region			
Plain	89.3	10.7	<0.001
Tonle Sap	86.6	13.4	
Coastal	89.0	11.0	
Plateau/Mountain	72.2	27.8	

226 *Notes: Survey weights are applied to obtain weighted percentages. *Plains: Phnom Penh, Kampong Cham, Tbong Khmum, Kandal,*
227 *Prey Veng, Svay Rieng, and Takeo; Tonle Sap: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap,*
228 *Battambang, Pailin, and Otdar Meanchey; Coastal/sea: Kampot, Kep, Preah Sihanouk, and Koh Kong; Mountains: Kampong Speu,*
229 *Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.*
230
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234 **Association between health insurance and maternal Healthcare Services Utilization**
 235

236 **Table 4** shows the results of the multiple logistic regression analysis of the association between
 237 health insurance coverage and maternal healthcare services utilization after controlling for the
 238 socio-demographic factors. Compared to women without health insurance, those with health
 239 insurance coverage were more likely to attend four or more ANC visits (AOR = 1.6, 95% CI: 1.1–
 240 2.4). Women with higher education (AOR = 3.1, 95% CI: 1.2–7.7), secondary education (AOR =
 241 2.3, 95% CI: 1.5–3.5), and primary education (AOR = 1.7, 95% CI: 1.2–2.7) were more likely to
 242 have four or more ANC visits than women without any formal education. The odds of having four
 243 or more ANC visits were more significant for women from the wealthiest households than for
 244 those from the poorest households: richest households (AOR = 3.2; 95% CI: 1.5-6.8), richer
 245 households (AOR = 1.9; 95% CI: 1.2-2.8), and middle households (AOR = 1.5; 95% CI: 1.1-2.2).
 246 However, the odds of having four or more ANC visits were lower in unmarried women than in
 247 married women (AOR = 0.5; 95% CI: 0.3-0.8).
 248

249 **Table 4.** Association between health insurance and four or more ANC visits in simple and multiple logistic
 250 regression model (N = 3,162)

Variables	Four or more ANC visits			
	Unadjusted		Adjusted	
	OR	95% CI	AOR	95% CI
Covered by health insurance				
No	Ref. 1.0		Ref. 1.0	
Yes	2.0***	(1.4-2.9)	1.6*	(1.1-2.4)
Age at time of birth				
15-30	Ref. 1.0		Ref. 1.0	
31-49	1.2	(0.7-2.1)	1.1	(0.6-2.0)
Marital status				
Married	Ref. 1.0		Ref. 1.0	
Not married	0.5**	(0.3-0.8)	0.5**	(0.3-0.8)
Birth order				
1 st -child	Ref. 1.0		Ref. 1.0	
2 nd or 3 rd children	1.0	(0.8-1.4)	1.1	(0.8-1.5)
4 th child or more children	0.5***	(0.4-0.7)	0.7*	(0.5-1.0)
Educational				
No education	Ref. 1.0		Ref. 1.0	
Primary	2.2***	(1.5-3.1)	1.8**	(1.2-2.7)
Secondary	3.7***	(2.6-5.3)	2.3***	(1.5-3.5)
Higher	8.9***	(4.3-18.3)	3.1*	(1.2-7.7)
Occupation				
Not working None	Ref. 1.0		Ref. 1.0	
Professional	3.8***	(2.0-7.0)	1.4	(0.7-2.8)

Sales	1.0	(0.7-1.4)	0.7	(0.5-1.0)
Agricultural	0.7*	(0.5-1.0)	1.0	(0.7-1.4)
Services	4.9**	(1.8-13.5)	2.6	(0.9-7.2)
Manual labor	1.7**	(1.2-2.3)	1.3	(0.9-1.9)
Wealth index				
Poorest	Ref.††		Ref.††	
Poorer	2.4***	(1.7-3.2)	1.7**	(1.2-2.3)
Middle	2.2***	(1.6-3.1)	1.5*	(1.1-2.2)
Richer	3.0***	(2.1-4.2)	1.9***	(1.2-2.8)
Richest	6.4***	(3.4-12.0)	3.2**	(1.5-6.8)
Residence				
Urban	Ref.††		Ref.††	
Rural	0.4***	(0.3-0.6)	0.8	(0.5-1.1)
Region				
Plain	Ref.††		Ref.††	
Tonle Sap	0.8	(0.6-1.1)	1.2	(0.9-1.7)
Coastal	1.0	(0.6-1.5)	1.3	(0.8-2.1)
Plateau/Mountain	0.3***	(0.2-0.4)	0.5***	(0.3-0.6)

Ref = reference value

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Survey weights are applied to obtain weighted percentages. *Plains: Phnom Penh, Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; Tonle Sap: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; Coastal/sea: Kampot, Kep, Preah Sihanouk, and Koh Kong; Mountains: Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.

Discussion

We analyzed the most recent 2021–2022 CDHS data to examine the relationship between health insurance coverage and receiving four or more ANC visits during pregnancy. Overall, 24.9% of women reported having health insurance coverage among women of reproductive age who gave birth within two years of the survey. This finding is slightly similar to lower-middle-income countries, where 27.3% of women had health insurance coverage [19]. This is higher than in low-income countries, where 7.9% of women have health insurance coverage [19]. However, lower than in upper-middle-income countries, 52.5% of women had health insurance coverage [19]. Since the formal launch of the Cambodia National Social Security Fund (NSSF) with the Health Insurance Scheme in 2008, the proportion of women with health insurance coverage has increased from 16% in 2014 to 22% in 2021–2022 [5]. This proportion exponentially increased due to the Royal Government of Cambodia’s implementation of the NSSF for all workers in the formal and informal sectors of the economy [10]. Moreover, it has plans to extend the healthcare benefits under the NSSF to the family members of the employees as well [16].

276 The proportion of women with health insurance coverage was found to be highest among women
277 with higher levels of education and those from better households. This is in line with a meta-
278 analysis of 48 studies conducted in 17 countries, which revealed a higher likelihood of health
279 insurance participation in the wealthiest and most educated households [21]. Additionally, women
280 with higher educational levels and wealth status consistently predicted health insurance ownership
281 among women at reproductive age across five Sub-Saharan African countries [22]. Furthermore,
282 we found women with health insurance coverage, a lower proportion among women living in rural
283 areas. Consistent with studies in Nigeria [9]. This suggests that the more vulnerable populations,
284 such as the poor, rural areas, and least educated, should be reached with government interventions
285 such as having health insurance coverage.

286 The proportion of pregnant women attending four or more antenatal care appointments has
287 increased considerably from 9% to 86.1% between 2000 and 2021. This study found that women
288 with health insurance coverage were 1.6 times more likely to attend four or more ANC visits during
289 pregnancy. Previous studies documented the positive relationship between health insurance and
290 the number of ANC visits among women of reproductive age [8,9,19]. Health insurance eliminates
291 the financial barrier to accessing maternal health services caused by out-of-pocket payments. It
292 has a beneficial effect in reducing the number of low-birth-weight babies born and child mortality
293 [17,23]. The result is more equitable access to care, potentially improving maternal health
294 outcomes [9,19]. The MoH has since raised the minimum standard for ANC visits during
295 pregnancy to at least four trips [20,24]. The dramatically significant increase in the highest
296 prevalence of four or more ANC visits was an effort by the Royal Government of Cambodia, which
297 has strengthened health facilities across the country, particularly in rural areas, improved
298 infrastructure, provided essential medical equipment and supplies, increased the number of
299 midwives, expanded antenatal care, and provided more skilled medical practitioners at childbirth
300 to ensure safe delivery practices. Furthermore, to encourage early and routine ANC visits, the
301 government is offering pregnant women a monetary incentive of [US\\$20 US dollars](#) for each visit
302 during a maximum of four ANC visits at any health facility with a contract with the National Social
303 Security Fund (NSSF) [14,25].

304
305 This study found that increased education and household wealth index increased the likelihood of
306 four or more ANC visits. Women's education and higher wealth index are more likely to attend

307 four or more ANC visits. This aligns with previous evidence around socio-economic inequalities
308 in maternal health service utilization in Cambodia and South Asia [26,27]. This may be because
309 the more educated the woman is, the more aware she is of the importance of ANC for her health
310 and baby [28]. Additionally, education gives women the power to decide whether to seek medical
311 attention and enables them to recognize warning signs of pregnancy complications. Moreover,
312 ~~the other hand,~~ women from higher-income households were more likely to be able to cover the
313 costs of care-seeking, including any related expenses and transportation [26,27]. Thus, in this study,
314 women with higher education levels and household wealth indexes had the highest proportion of
315 health insurance coverage.

316
317 This study has several strengths. First, it used the most recent women's data from the 2021–2022
318 CDHS, an extensive representative national population-based household survey with a high
319 response rate of 97%. Second, the recall bias has been minimized by limited analysis of women's
320 most recent deliveries within the last two years preceding the survey [5]. ~~Data were collected using~~
321 ~~validated survey methods and highly trained data collectors, contributing to improved data quality~~
322 [29]. Third, the complex survey design and sampling weights in the analysis accounted for both
323 descriptive and analytics methods that enabled us to generalize our findings to the population of
324 WRA in Cambodia. ~~In addition, DHS data were collected using validated survey methods and~~
325 ~~highly trained data collectors, contributing to improved data quality~~ [29]. Lastly, to our knowledge,
326 this is the first study to report the association between health insurance coverage and ANC visits
327 in Cambodia. After controlling sociodemographic factors, we found significant associations
328 between health insurance coverage and several forums or more ANC visits. A key finding
329 compares the association with other studies in Southeast Asia and globally.

330

331 Despite this, there are several limitations. First, this study ~~was—used~~ a [secondary](#)
332 [analysis household-based survey](#), so it did not address health institution factors of antenatal care
333 utilization and service availability; hence, this study could not explore the quality of ANC services,
334 though the quality of healthcare services plays a vital role in patient satisfaction and use. Second,
335 the study's cross-sectional nature could not assist in the temporal relationship of variables [including](#)
336 [the number of years since women joined health insurance on ANC utilization](#). Therefore, further
337 study should be conducted to identify factors related to health institutions. In addition, antenatal
338 care utilization should be performed based on the new WHO guidelines [revised in 2016](#) at the
339 national level [24].

340 Moreover, longitudinal studies that address comprehensive variables should be studied. Third, we
341 excluded other factors, such as maternal complications and women's empowerment indicators, that
342 could affect the use of maternal care. Lastly, CDHS did not assess a direct measure of maternal
343 health literacy.

344

345 **Conclusion**

346

347 This is the first study to report the association between health insurance coverage and ANC visits
348 in the healthcare setting in Cambodia. Cambodian pregnant women attend four or more antenatal
349 care visits, which is slightly high. However, it still needs to be satisfactory. **Health among coverage**
350 **women of reproductive age in Cambodia is relatively low.** Moreover, we found that women with
351 health insurance, women with education, and being rich in the wealth quintile were strong
352 predictors of women attending four or more ANC visits. There is a need to pay close attention to
353 improving the uptake of health insurance among women of reproductive age, especially targeting
354 women with no education, from low-income families, and women who reside in rural areas.
355 Policymakers may need to prioritize women of reproductive age in designing and implementing
356 health insurance programs to increase their uptake. This would provide financial risk protection,
357 facilitate access to maternal health services, and possible attainment of Cambodia's SDG 3 targets.

358

359 **Acknowledgments**

360 The authors would like to thank DHS-ICF, who approved the data used for this paper.

361

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Authors' point-by-point responses to the editor and reviewers

Manuscript ID: PGPH-D-24-00222

Manuscript Titled: Health insurance coverage and antenatal care utilization in Cambodia: Analysis of Cambodia Demographic and Health Survey 2021-22

PLOS Global Public Health

Dear editor and reviewers,

We would like to thank all the reviewers and editor for providing their important time and effort in reviewing our manuscript. We have addressed all comments where relevant, as listed below:

1. Additional Editor Comments:

This paper tried to examine the effects of health insurance coverage and antenatal care (ANC) utilization among pregnant women in Cambodia. Although the reviewers raised some concerns regarding this paper. My major concern is the analysis regarding the table 4 multiple logistic regression model where the authors showed a significant relationship among the insured and non-insured mother regarding the recommended ANC service utilization. The authors conclude compared to women without health insurance, those with health insurance coverage were 1.6 times more likely to attend four or more ANC visits. However, Table 4 also indicated that, most of the explanatory variables have a positive relationship with outcome variables. Even we observed that richest and higher educated mother utilized 3.2 and 3.1 times higher than their counterpart which is higher than having insurance variable. Therefore, I wondered education and wealth more important than having health insurances. Please clarify? The paper is fine, if the authors change the title of this paper to find out the determinants of ANC service utilization using Cambodia DHS data. However, to examine the effect of health insurance, I would like to see the reanalysis with two separate models for the mothers who were belonged to the health insurance coverage and who have not. Indeed, without propensity score matching, I believed the impact of health insurance on ANC service utilization may be questionable. See the related papers

Author's response: On page 1 of the manuscript, we have adopted and modified the title accordingly, and now reads “The effect of health insurance coverage on antenatal care utilization in Cambodia: A secondary analysis of Cambodia Demographic and Health Survey 2021-2022”.

Author's response: We have revised the manuscript to explain the concerns with the result presented in “Table 4 multiple logistic regression model” To check for a high correlation among the independent variables, a test for multicollinearity was carried out among independent variables was checked before fitting the final multiple logistic regression model, including coverage health insurance, women's age,

number of children ever born, education, wealth index, occupation, marital status, and place of residence. The result of the evaluating variance inflation factor (VIF) scores after fitting an Ordinary Least Squares regression model with the mean value of VIF was 1.53, which is less than the cutoff point indicating no collinearity correlation among the independent variables. Next, a multiple logistic regression was conducted to examine the independent association between health insurance coverage and other covariates on ANC utilization. The selection of variables into the multiple logistic regression model was based on the previously published papers provided in reference numbers #6, #18 and their statistical significance in the Chi-square test at $p\text{-value} \leq 0.10$.

Authors' response: We have asked professional editing services to revise and make corrections grammatically and accordingly, as suggested.

2. Reviewers' comments:

Reviewer #1: please correct 15-59 years as 15-49 years in line number 116 (page 4). Complete the line 133 -descriptive and analytical analysis or something like this. Make the line 141 correct, there is no verb in this sentence. Rewrite the sentence /line number149. Correct/rewrite line number 257,258. Read carefully the full text.

Authors' response: We have revised the manuscript accordingly.

Reviewer #2: Thank you for sharing the manuscript and would like to congratulate them for their nice work. My few comments/clarification questions are incorporated in the manuscript.

1. Did the study assess the cut-off period to identify the association between access to maternal health and years of membership/participation in health insurance?

Authors' response: cut-off period or years of membership/participation in health insurance were not included in the CDHS 2022 questionnaire.

2. What is the particular interest of the researchers only using 2021-2022 data?

Authors' response: The results are more reliable and reflect the current situation among women in Cambodia. Moreover, the findings of the study on the effect of health insurance coverage on antenatal care utilization are similar to other studies (for example, references #6, and #18), and the result can be used as a baseline value for comparison in the future.

3. How do you assess the confounding effects of other variables such as income, and level of education? Because those with better education and income are likely to attend 4 or more ANC visits.

Authors' response:

The multicollinearity test was carried out among independent variables that were checked before fitting the final multiple logistic regression model, including coverage health insurance, women's age, number of children ever born, education, wealth index, occupation, marital status, and place of residence. The result of the evaluating variance inflation factor (VIF) scores after fitting an Ordinary Least Squares regression model with the mean value of VIF was 1.53, which is less than the cutoff point indicating no collinearity correlation among the independent variables.

Next, a multiple logistic regression was conducted to examine the independent association between health insurance coverage and other covariates on ANC utilization.

The selection of variables into the multiple logistic regression model was based on the previously published papers provided in reference numbers #6, #18 and their statistical significance in the Chi-square test at $p\text{-value} \leq 0.10$.

For instance, according to multiple logistic regression models with an interaction term between wealth index and education, there is no association between several ANC visits and wealth and education.

4. Just for curiosity, is those women who did not attend any ANC visit categorized under less than 4 ANC visit?

Authors' response: less than 4 ANC visits were included in women who reported no ANC visits.

5. Did the study assess the association between the number of years since they joined the insurance and ANC use?

Authors' response: the number of years since they joined the health insurance was not included in the CDHS 2022 questionnaire. This is a limitation of the study.

Reviewer #3: Thank you for the opportunity to review this manuscript titled "Health insurance coverage and antenatal care utilization in Cambodia: Analysis of Cambodia Demographic and Health Survey 2021-22"

Title: I can see that title has two outcome variables (Health insurance coverage and ANC utilization) and no independent variable. It would be better to have this put to look a complete topic. Example; you can write, "Factors Associated with Health Insurance and ANC Utilization....."

Author's response: We have modified the title accordingly, and now reads "The effect of health insurance coverage on antenatal care utilization in Cambodia: A secondary analysis of Cambodia Demographic and Health Survey 2021-2022".

Methods: In the outcome variable section you stated that "This study's outcome was the number of ANC visits..." I can see that you left out another important outcome variable, i.e Health

Insurance Coverage. Please update this section. Further, I can see that you used these two outcome variables very well in your result section (see Table 2 & Table 3).

Author's response: To clarify the outcome variable was women attended four or more ANC visits. Now, Table 2 removed.

Results: Update your topic that reflect the independent variables used in result. I gave a suggestion how the title can be improved.

Author's response: To clarify, now we have modified the title accordingly “The effect of health insurance coverage on antenatal care utilization in Cambodia: A secondary analysis of Cambodia Demographic and Health Survey 2021-2022”. Table 2 removed.

Data sharing: Write a statement on data related to your study and indicate the URL link for the data

Author's response: We have revised the manuscript accordingly. *“The Demographic and Health Survey data are publicly available from the website: (URL: https://www.dhsprogram.com/data/dataset_admin) and are accessible after registration on the website. The authors did not have special access privileges.”*

Reviewer #4: The manuscript adequately responds to the research question based on the predefined scope. This is a secondary analysis of data from a demographic and health survey. The author should be keen not to describe the survey in the methodology instead of the approaches of the current study. Minor comments are included in the attached manuscript for author review.

Author's response: We have revised the manuscript accordingly as following all reviewers suggested.

Reviewer #5: I am glad to have had the opportunity to review this pertinent and interesting paper. The paper addresses a relevant issue, both socially and scientifically; however, I believe some changes could clarify and improve the current manuscript. Please find my comments below:

Author's response: We have revised the manuscript accordingly as following all reviewers suggested.