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Association between relative income and mental health in adults during the COVID-19
pandemic in Korea: Insights from a community health survey

Short title: Relative Income and Mental Health during COVID-19

Min Hui Moon^{1,2}, Min Hyeok Choi^{1,2*}

¹Department of Preventive and Occupational & Environmental Medicine, Medical College,
Pusan National University, Yangsan, Republic of Korea

²Office of Public Healthcare Service, Pusan National University Yangsan Hospital, Yangsan,
Republic of Korea

*Corresponding author
E-mail: come2mh@gmail.com (MHC)

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
These authors contributed

27 Conceptualization: Min Hyeok Choi.
28 Data curation: Min Hui Moon.
29 Formal analysis: Min Hui Moon.
30 Investigation: Min Hui Moon, Min Hyeok Choi.
31 Methodology: Min Hui Moon, Min Hyeok Choi.
32 Supervision: Min Hyeok Choi.
33 Validation: Min Hui Moon, Min Hyeok Choi.
34 Writing – original draft: Min Hui Moon, Min Hyeok Choi.

35

36 **Abstract**

37 People of lower socioeconomic status are much more likely to be vulnerable to
38 COVID-19. This study aimed to compare the associations between mental health according to
39 relative national and community income levels during the COVID-19 pandemic. Mental
40 health inequalities according to income level during the COVID-19 pandemic were assessed
41 using the Korea Community Health Survey before (2019) and after the COVID-19 pandemic
42 (2021). Univariate analyses were used to calculate the perceived stress and depression rates
43 according to the risk factor categories. A multivariate logistic regression analysis was
44 performed to identify the association between two types of income levels (Korean or
45 community) and perceived stress and depression. In addition, we investigated the effect of
46 relative income levels by subgroup (gender and region) on perceived stress and the experience
47 of depression. During COVID-19, although depression crude rates increased (from 6.24% to
48 7.2%), perceived stress crude rates remained similar. In addition, as for mental health
49 inequality according to community income level, even after adjusting for each independent
50 variable, perceived stress [Odds Ratio (OR): 1.31, 95% Confidence Interval (CI):1.31–1.32]
51 and experience of depression (OR: 1.63, 95% CI: 1.62–1.63) increased as the income level

52 decreased. The effect of relative income level on perceived stress rate was found to be more
53 pronounced in urban areas than in rural areas in terms of community income levels.
54 Contrarily, the effect of relative income level on the depression rate was found to be weaker.
55 Our findings demonstrated that mental health inequalities based on income level were more
56 likely to occur during the COVID-19 pandemic and that disparities in community income
57 levels may better reflect mental health inequalities.

58

59 **Introduction**

60 The coronavirus disease (COVID-19) pandemic has significantly impacted mental
61 health worldwide, including stress, anxiety, and depression worldwide [1,2]. According to a
62 2021 OECD report (Hewlett, E. et al.), the prevalence of depression in OECD countries has
63 approximately doubled since the COVID-19 pandemic, with the prevalence being the highest
64 in Korea at 36.8% among OECD countries [3]. During the COVID-19 pandemic, social
65 distancing and containment measures had a direct impact on mental health [4-6] . Several
66 previous studies have reported that large-scale infectious diseases can cause emotional
67 confusion and difficulties such as depression and anxiety [7-12]. Cao et al. [7] and Shevlin et
68 al. [11] explored the effects of the COVID-19 pandemic and social isolation on mental health,
69 and Lee et al. [9] investigated factors related to fear of the COVID-19 infection and its
70 psychological and social impact. Furthermore, studies have shown that social isolation due to
71 COVID-19 and fear and awareness of the infection increases symptoms of depression and
72 anxiety [4].

73 Mental health related to stress and depression is affected by socioeconomic risk
74 factors such as education level, occupation, and income level. According to Patel et al.'s [13]
75 study on the effect of income level on mental health inequality among representative
76 socioeconomic factors, 33 surveys conducted in 20 countries reported that the lower the

77 income level, the higher the risk of depression. Hong et al. [14] found that inequality based on
78 income level is more pronounced in mental health than in physical health, doubling the size of
79 inequality over 10 years. Several other studies have consistently shown that people with lower
80 socioeconomic status are more vulnerable to mental health problems [13-18]. Several studies
81 have identified mental health inequality according to income level at the national level.
82 Meanwhile, Song A and Kim W [15] studied income inequality at the national as well as
83 community levels. As income inequality at the community level has a significant impact on
84 social capital and access to healthcare infrastructure, measuring health gaps is more useful
85 than income inequality at the national level [15,16].

86 The COVID-19 pandemic has exacerbated health inequalities among populations with
87 low socioeconomic status. For example, the lower the education level, income level, or
88 unstable employment status, the higher the risk of COVID-19 infection, and the higher the
89 critical severity and mortality rate [19-25]. Hall et al. [19] examined the impact of income
90 inequality on daily life and mental health during the COVID-19 pandemic. The results
91 showed that the low-income population had difficulty purchasing food and daily necessities,
92 and their health status deteriorated because of a lack of time and resources for proper
93 healthcare. Owing to this influence, the low-income group showed unstable mental health
94 conditions, such as stress and depression, compared to the high-income group.

95 Previous studies have confirmed that a) mental health issues, such as stress and
96 depression, deteriorated due to the COVID-19 pandemic, and b) there were differences in
97 mental health according to income level [13-15]. These studies were often limited to income
98 inequality at the national level; few studies have analyzed the relationship between income
99 inequality and mental health at the community level, which can reflect the accessibility of
100 healthcare infrastructure in the region.

101 This study aimed to identify changes in mental health according to income level

102 before (2019) and after (2021) the COVID-19 pandemic. In addition, it was conducted to
103 provide a policy basis for improving mental health inequality by comparing the patterns of
104 health inequality according to income at the national and community levels.

105 Therefore, the purpose of this study was to:

- 106 1) Identify and compare levels of perceived stress and depression according to income
107 level during the COVID-19 pandemic.
- 108 2) During the COVID-19 pandemic, we analyzed the relationship between perceived
109 stress and the experience of depression on mental health according to the relative
110 income levels of the total (Korean income level) and local (community income level)
111 population.
- 112 3) Investigate the effect of relative income levels by subgroup (gender and region) on
113 perceived stress and experiences of depression.

114

115 **Materials and methods**

116 **Data and study population**

117 Data were obtained from the Korea Community Health Survey (KCHS). Since 2008,
118 the Community Health Survey (CHS) has been conducted annually by the Korea Centers for
119 Disease Control and Prevention. The CHS is a large-scale survey in which about 220,000
120 people nationwide participate from August to October every year and includes questions on
121 chronic disease screening, health behavior, food intake, and socioeconomic status. Survey
122 data were used as official national indicators such as health level, health behavior, food and
123 nutrition intake, and chronic disease prevalence in Korea (Korea Community Health Survey
124 Guidelines, website: <http://chs.kdca.go.kr/>). This survey was conducted in the form of a 1:1
125 interview with a surveyor visiting households of adults aged 19 or older residing in 255 cities,

126 counties, and districts in Korea. Research participants were selected through probability
127 proportional sampling and systematic sampling every year. This study selected 449,234
128 people, excluding those who did not respond, as the final study participants out of 458,341
129 people who participated in community health surveys in 2019 and 2021.

130

131 **Variables**

132 **Dependent variables**

133 The dependent variables included perceived stress and depression. Perceived stress
134 and depression are representative indicators of mental health, and stress plays an important
135 role in predicting depression [26-28]. Several studies have demonstrated that exposure to
136 perceived stress and experiences of depression are associated with poor health outcomes and
137 affect socioeconomic imbalance [29-31]. Low socioeconomic status is associated with a high
138 prevalence of stress and depression; mental health in low-income groups is particularly
139 aggravated by persistent poverty and income inequality [32-34]. Perceived stress was assessed
140 using the question, “How stressful do you feel in your daily life?” with response options of
141 “feel very much,” “feel a lot,” “feel a little bit,” and “hardly feel it.” For the analysis, those
142 who responded “I feel it very much” and “I feel it a lot” were classified as those who usually
143 feel stress in my daily life, and those who answered “I feel it a little” and “I hardly feel it” was
144 classified as a person who doesn't. The experience of depression was surveyed using the
145 following question: “Did you feel sadness or despair enough to bother you in your daily life
146 for more than 2 weeks in the last year?” Their answer was recorded as “yes” or “no.” In this
147 study, a participant was defined as one who answered “yes.”

148

149 **Independent variables**

150 The health inequality variable, considered a major factor in this study, was income

151 level. The income level is an indicator of socioeconomic status that can be used to directly
152 measure the material resources available to individuals. It is a representative indicator of
153 socioeconomic inequality and is widely used because it implies that income inequality affects
154 health outcomes. Income level is closely related to health; the lower the income level, the
155 higher the rate of unhealthy states [35,36]. The income level used in this study was the
156 equalized income calculated by dividing household income by the square root of the
157 household members. The Korean income level reconstructs the average income level of the
158 entire population into the third quintile, and the community income level is set by dividing it
159 into third quintiles based on the average income level of 255 cities, counties, and districts.

160 The general factors associated with perceived stress and experience of depression were
161 included as independent variables after reviewing studies that previously reported mental
162 health risk factors [37-39]. Demographic variables included gender (men or women), age
163 group (19–29, 30–64, or ≥ 65), and area of residence (urban or rural). Social-economic
164 parameters included education level (\leq middle school, \leq high school, or college or above), job
165 status (economic activity or non-economic activity), marital status (married or not married)
166 and the basic livelihood condition. Health behavior factors included current smoking (yes or
167 no), high-risk drinking (men: drinking seven standard drinks or more over once a week,
168 women: drinking five standard drinks or more over once a week), and walking practice
169 (walking activity for ≥ 30 min, \geq five days in the previous week).

170

171 **Statistical analysis**

172 Perceived stress and depression rates were calculated by performing univariate
173 analysis according to the dependent variables. Statistically significant differences in perceived
174 stress and experiences of depression were verified by performing the Rao-Scott chi-square
175 test. The association between two types of income levels (Korean and community income

176 levels) and mental health (perceived stress and experience of depression) was analyzed by
177 performing a complex-sample multivariate logistic regression analysis to adjust for other
178 variables. Subgroup analysis was performed based on two types of income levels (Korean and
179 community income levels), gender, and area of residence. Statistical significance was set at a
180 p-value of <0.05. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary,
181 NC, USA).

182

183 **Ethical considerations**

184 This study was approved by the Institutional Review Board of Pusan National
185 University Hospital (IRB No. 04-2022-030). All the participants provided written informed
186 consent for the KCHS. The survey was conducted after sufficiently explaining to the
187 participants that the results would be used for statistical purposes only and that confidentiality
188 was guaranteed. The need for informed consent was waived by the IRB because the data were
189 analyzed anonymously.

190

191 **Results**

192 Table 1 shows the general characteristics of the study population. The total number of
193 participants was 449,234, and the number of weighted analysis participants was 84,491,967
194 (41,590,294 in 2019 and 42,901,673 in 2021). The proportions of men and women were
195 similar (49.66% in 2019 and 49.62% in 2021), and those aged 30–64 years were the most
196 common subgroup population (63.73% in 2019 and 62.75% in 2021). Regarding population
197 distribution by Korean income levels, Q1 (high) had the highest, followed by Q2 and Q3. The
198 same was found for community income levels. The perceived stress rates were 24.78% in
199 2019 and 2021. The experience of depression rates are 6.25% and 7.2% in 2019 and 2021,

200 respectively.

201

202 **Table 1. General characteristics of the study population.**

		2019			2021		
		N	Weight N	Weight %	N	Weight N	Weight %
Total		223,288	41,590,294	100.00	225,946	42,901,673	100.00
Gender	Men	100,076	20,653,435	49.66	103,022	21,287,731	49.62
	Women	123,212	20,936,859	50.34	122,924	21,613,942	50.38
Age group	19–29	22,727	7,169,375	17.24	24,313	7,128,368	16.62
	30–64	127,860	26,506,490	63.73	128,100	26,921,724	62.75
	≥65	72,701	7,914,429	19.03	73,533	8,851,581	20.63
Area of residence	Urban	124,739	33,750,880	81.15	127,315	34,870,498	81.28
	Rural	98,549	7,839,414	18.85	98,631	8,031,175	18.72
Education	Middle school	79,077	8,303,254	19.96	72,123	7,962,562	18.56
	High school	63,962	12,329,258	29.64	65,490	12,488,195	29.11
	College and above	80,249	20,957,782	50.39	88,333	22,450,916	52.33
Job status	Economically active	138,739	26,473,047	63.65	141,544	27,324,490	63.69
	Non-active	84,549	15,117,247	36.35	84,402	15,577,183	36.31
Marital status	Married	148,579	26,627,752	64.02	142,120	26,190,336	61.05
	Not married	74,709	14,962,542	35.98	83,826	16,711,337	38.95
Korea income level^a	Q1 (high)	75,415	18,462,860	44.39	80,798	19,667,569	45.84
	Q2 (middle)	74,948	14,451,252	34.75	70,232	13,493,676	31.45
	Q3 (low)	72,925	8,676,182	20.86	74,916	9,740,428	22.70
Community income level^a	Q1 (high)	76,829	15,797,359	37.98	77,732	16,008,586	37.31
	Q2 (middle)	71,527	13,580,193	32.65	72,386	13,889,434	32.38
	Q3 (low)	74,932	12,212,742	29.36	75,828	13,003,653	30.31
Basic livelihood condition	Yes	8,837	1,312,334	3.16	10,692	1,694,212	3.95
	No	214,451	40,277,960	96.84	215,254	41,207,461	96.05
Smoking status	Yes	186,250	33,694,788	81.02	189,588	35,342,643	82.38
	No	37,038	7,895,506	18.98	36,358	7,559,030	17.62
High-risk drinking^b	Yes	198,249	36,136,004	86.89	205,720	38,690,084	90.18
	No	25,039	5,454,290	13.11	20,226	4,211,589	9.82
Physical activity^c	Yes	89,671	18,967,814	45.61	93,778	19,377,491	45.17
	No	133,617	22,622,480	54.39	132,168	23,524,182	54.83
Perceived stress	Yes	49,319	10,305,831	24.78	50,169	10,630,372	24.78
	No	173,969	31,284,463	75.22	175,777	32,271,301	75.22
Experience of depression	Yes	13,731	2,598,126	6.25	16,129	3,088,224	7.20
	No	209,557	38,992,168	93.75	209,817	39,813,449	92.80

203 ^aCategorized using equivalent income; Q1: high-income level; Q2: middle-income level; Q3:

204 low-income level

205 ^bDrinking alcohol: men who drank seven standard drinks or more once a week; women who
 206 drank five standard drinks or more once a week

207 ^cWalking activity ≥ 30 minutes, \geq five days in the last week.

208

209 Table 2 shows perceived stress and experiences of depression according to the factors
 210 identified in 2019 and 2021. Perceived stress is significantly higher in women than in men in
 211 both 2019 and 2021 ($p < 0.0001$). It was most common in the 30–64 subgroup population,
 212 followed by those aged 19–29 and ≥ 65 years. Perceived stress according to the Korean
 213 income level was significantly higher as the relative income level increased, and the
 214 community income level was also confirmed by the same result. The number of people living
 215 in urban areas was higher than in rural areas. Economic activity was significantly higher than
 216 in the non-economic activity group ($p < 0.0001$). Depression was significantly higher in
 217 women than in men in both 2019 and 2021 and occurred most commonly in the ≥ 65 years age
 218 group. In 2019 and 2021, the experience of depression rates of lowest Korean income group
 219 (Q3) is significantly higher. Community income levels showed the same results ($p < 0.0001$).

220

221 **Table 2. Perceived stress and experience of depression according to factors during the**
 222 **COVID-19 pandemic.**

		Perceived stress				Experience of depression			
		2019		2021		2019		2021	
		N	%	N	%	N	%	N	%
Gender	Men	20,789	20.77	21,384	20.76	4,350	4.35	5,315	5.16
	Women	28,530	23.16	28,785	23.42	9,381	7.61	10,814	8.80
<i>p</i> -value ^a		<.0001		<.0001		<.0001		<.0001	
Age group	19–29	6,164	27.12	6,377	26.23	1,212	5.33	1,479	6.08
	30–64	31,118	24.34	32,499	25.37	7,385	5.78	8,845	6.90
	≥ 65	12,037	16.56	11,293	15.36	5,134	7.06	5,805	7.89
	<i>p</i> -value	<.0001		<.0001		<.0001		<.0001	

Area of residence	Urban	29,908	23.98	30,809	24.20	8,002	6.41	9,513	7.47
	Rural	19,411	19.70	19,360	19.63	5,729	5.81	6,616	6.71
	p-value	<.0001		<.0001		<.0001		<.0001	
Education	Middle school	14,977	18.94	12,720	17.64	6,071	7.68	6,431	8.92
	High school	14,005	21.90	14,807	22.61	3,859	6.03	4,613	7.04
	College and above	20,337	25.34	22,642	25.63	3,801	4.74	5,085	5.76
	p-value	<.0001		<.0001		<.0001		<.0001	
Job status	Economically active	32,579	23.48	33,707	23.81	6,539	4.71	8,034	5.68
	Non-active	16,740	19.80	16,462	19.50	7,192	8.51	8,095	9.59
	p-value	<.0001		<.0001		<.0001		<.0001	
Marital status	Married	31,855	21.44	30,680	21.59	7,679	5.17	8,507	5.99
	Not married	17,464	23.38	19,489	23.25	6,052	8.1	7,622	9.09
	p-value	<.0001		<.0001		<.0001		<.0001	
Korean income level	Q1 (high)	17,713	23.49	19,217	23.78	3,328	4.41	4,217	5.22
	Q2 (middle)	16,244	21.67	15,456	22.01	4,071	5.43	4,381	6.24
	Q3 (low)	15,362	21.07	15,496	20.68	6,332	8.68	7,531	10.05
	p-value	<.0001		<.0001		<.0001		<.0001	
Community income level	Q1 (high)	17,237	22.44	17,670	22.73	3,313	4.31	3,964	5.10
	Q2 (middle)	15,551	21.74	16,074	22.21	3,786	5.29	4,523	6.25
	Q3 (low)	16,531	22.06	16,425	21.66	6,632	8.85	7,642	10.08
	p-value	<.0001		<.0001		<.0001		<.0001	
Basic livelihood condition	Yes	2,761	31.24	3,132	29.29	1,443	16.33	1,930	18.05
	No	46,558	21.71	47,037	21.85	12,288	5.73	14,199	6.60
	p-value	<.0001		<.0001		<.0001		<.0001	
Smoking status	Yes	10,406	28.10	10,288	28.30	2,391	6.46	2,776	7.64
	No	38,913	20.89	39,881	21.04	11,340	6.09	13,353	7.04
	p-value	<.0001		<.0001		<.0001		<.0001	
High-risk drinking	Yes	6,887	27.51	5,745	28.40	1,418	5.66	1,439	7.11
	No	42,432	21.40	44,424	21.59	12,313	6.21	14,690	7.14
	p-value	<.0001		<.0001		<.0001		<.0001	
Physical activity	Yes	18,727	20.88	19,411	20.70	4,914	5.48	5,947	6.34
	No	30,592	22.90	30,758	23.27	8,817	6.60	10,182	7.70
	p-value	<.0001		<.0001		<.0001		<.0001	

223 ^a Results of the Rao-Scott chi-square test

224

225 Table 3 presents the influence of the two types of income levels (Korean and
 226 community income levels) on perceived stress and experiences of depression by gender. Both
 227 Korean and community income levels were significant factors for perceived stress and
 228 depression after adjusting for the impacts of other factors in both 2019 and 2021. The odds
 229 ratio (OR) of Korean income level of perceived stress was 1.30 (95% Confidence Interval
 230 (CI) 1.30–1.30, $p < 0.0001$) and 1.29 (95% CI 1.28–1.29, $p < 0.0001$) in 2019 and 2021,
 231 respectively. According to the community income level, the perceived stress for the low-
 232 income level group was 1.26 (95% CI 1.26–1.26) and 1.31 (95% CI 1.31–1.32) in 2019 and
 233 2021, respectively, compared to the high-income level group. The experience of depression
 234 was significantly lower in the high-income group than in the low-income group ($p < 0.0001$).
 235 According to the community income level, perceived stress and experience of depression
 236 were both high in the low-income group (2019 OR 1.55, 95% CI 1.55–1.56, 2021 OR 1.63,
 237 95% CI 1.62–1.63). Comparing before and after the COVID-19 pandemic, perceived stress by
 238 income level decreased and increased at the Korean and community income level,
 239 respectively. During the COVID-19 pandemic, the magnitude of inequality in the experience
 240 of depression increased for both types.

241
 242 **Table 3. Influence of the two types of income levels (Korean or community income**
 243 **levels) on perceived stress and experience of depression by gender based on complex-**
 244 **sample multivariate logistic regression analysis.**

	Perceived stress				Experience of depression				
	2019		2021		2019		2021		
	Adj OR ^a (95% CI ^b)	<i>p</i> - value	Adj OR ^a (95% CI ^b)	<i>p</i> - value	Adj OR ^a (95% CI ^b)	<i>p</i> - value	Adj OR ^a (95% CI ^b)	<i>p</i> - value	
Total									
Korean income level	Q1	Reference	Reference		Reference		Reference		
	Q2	1.09 (1.09-1.09)	<.0001	1.10 (1.10-1.11)	<.0001	1.21 (1.21-1.22)	<.0001	1.17 (1.17-1.18)	<.0001
	Q3	1.30 (1.30-1.30)	<.0001	1.29 (1.28-1.29)	<.0001	1.72 (1.71-1.72)	<.0001	1.73 (1.72-1.73)	<.0001
Community income level	Q1	Reference	Reference		Reference		Reference		
	Q2	1.07	<.0001	1.11	<.0001	1.12	<.0001	1.11	<.0001

		(1.07-1.07)		(1.11-1.11)		(1.11-1.12)		(1.11-1.12)	
	Q3	1.26 (1.26-1.26)	<.0001	1.31 (1.31-1.32)	<.0001	1.55 (1.55-1.56)	<.0001	1.63 (1.62-1.63)	<.0001
Men									
	Q1	Reference		Reference		Reference		Reference	
Korean income level	Q2	1.04 (1.04-1.04)	<.0001	1.08 (1.08-1.09)	<.0001	1.15 (1.14-1.15)	<.0001	1.13 (1.12-1.14)	<.0001
	Q3	1.21 (1.20-1.21)	<.0001	1.24 (1.23-1.24)	<.0001	1.64 (1.63-1.65)	<.0001	1.75 (1.74-1.76)	<.0001
	Q1	Reference		Reference		Reference		Reference	
Community income level	Q2	1.05 (1.04-1.05)	<.0001	1.08 (1.08-1.08)	<.0001	1.12 (1.11-1.13)	<.0001	1.08 (1.08-1.09)	<.0001
	Q3	1.20 (1.20-1.20)	<.0001	1.27 (1.26-1.27)	<.0001	1.48 (1.47-1.49)	<.0001	1.65 (1.64-1.66)	<.0001
	Q1	Reference		Reference		Reference		Reference	
Women									
	Q1	Reference		Reference		Reference		Reference	
Korean income level	Q2	1.15 (1.14-1.15)	<.0001	1.13 (1.12-1.13)	<.0001	1.24 (1.24-1.25)	<.0001	1.19 (1.18-1.19)	<.0001
	Q3	1.39 (1.38-1.39)	<.0001	1.33 (1.32-1.33)	<.0001	1.71 (1.70-1.72)	<.0001	1.67 (1.66-1.68)	<.0001
	Q1	Reference		Reference		Reference		Reference	
Community income level	Q2	1.10 (1.10-1.10)	<.0001	1.14 (1.14-1.14)	<.0001	1.11 (1.11-1.12)	<.0001	1.13 (1.13-1.13)	<.0001
	Q3	1.32 (1.31-1.32)	<.0001	1.35 (1.35-1.36)	<.0001	1.56 (1.55-1.57)	<.0001	1.59 (1.58-1.59)	<.0001

245 ^aAdj OR, adjusted odds ratio; ^bCI, confidence interval; adjusted for gender, age, education,
 246 job status, marital status, basic livelihood condition, smoking status, high-risk drinking, and
 247 physical activity.

248

249 Table 4 shows the results of the subgroup analysis that investigated the income level
 250 between the stress perception and experience of depression rates by gender and area of
 251 residence. Excluding the Korean income of men living in rural areas in 2021, the magnitude
 252 of inequality in stress perception was statistically significant ($p < 0.0001$). The size of the
 253 inequality in experiences of depression was statistically significant in both 2019 and 2021,
 254 except for men living in rural areas with a Korean income level ($p < 0.0001$). In both 2019 and
 255 2021, the stress perception rate based on Korean income level showed greater inequality in
 256 urban areas. Furthermore, community income levels showed greater inequality in urban and
 257 rural areas in 2019 and 2021, respectively. The magnitude of inequality in perceived stress by
 258 gender was higher for women in both 2019 and 2021. In addition, the magnitude of inequality
 259 in the depression recognition was larger for women than for men; however, in 2021, only the

260 magnitude of inequality for men living in rural areas was higher than that for women.

261

262 **Table 4. Influence of the two types of income level (Korean or community income level)**

263 **on perceived stress and experience of depression by gender and region of residence**

264 **based on complex-sample multivariate logistic regression analysis.**

			Perceived stress				Experience of depression			
			2019		2021		2019		2021	
			Adj OR ^a (95% CI ^b)	p-value	Adj OR ^a (95% CI ^b)	p-value	Adj OR ^a (95% CI ^b)	p-value	Adj OR ^a (95% CI ^b)	p-value
Total										
Urban	Korean income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.07 (1.07-1.07)	<.0001	1.12 (1.11-1.12)	<.0001	1.10 (1.10-1.11)	<.0001	1.10 (1.10-1.10)	<.0001
		Q3	1.26 (1.26-1.26)	<.0001	1.31 (1.30-1.31)	<.0001	1.53 (1.53-1.54)	<.0001	1.63 (1.62-1.64)	<.0001
	Community income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.11 (1.11-1.11)	<.0001	1.12 (1.12-1.13)	<.0001	1.23 (1.22-1.23)	<.0001	1.17 (1.17-1.17)	<.0001
		Q3	1.33 (1.33-1.33)	<.0001	1.30 (1.30-1.30)	<.0001	1.76 (1.75-1.76)	<.0001	1.73 (1.73-1.74)	<.0001
Rural	Korean income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.08 (1.07-1.08)	<.0001	1.07 (1.07-1.08)	<.0001	1.19 (1.18-1.20)	<.0001	1.18 (1.17-1.19)	<.0001
		Q3	1.25 (1.24-1.26)	<.0001	1.34 (1.33-1.35)	<.0001	1.62 (1.61-1.63)	<.0001	1.62 (1.61-1.64)	<.0001
	Community income level	Q1	Reference		Reference		Reference		Reference	
		Q2	0.98 (0.98-0.99)	<.0001	1.01 (1.00-1.01)	0.0004	1.11 (1.10-1.12)	<.0001	1.17 (1.16-1.18)	<.0001
		Q3	1.15 (1.15-1.16)	<.0001	1.21 (1.20-1.21)	<.0001	1.51 (1.50-1.53)	<.0001	1.71 (1.69-1.72)	<.0001
Men										
Urban	Korean income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.04 (1.04-1.04)	<.0001	1.09 (1.08-1.09)	<.0001	1.12 (1.11-1.13)	<.0001	1.07 (1.07-1.08)	<.0001
		Q3	1.21 (1.21-1.22)	<.0001	1.26 (1.25-1.26)	<.0001	1.48 (1.47-1.48)	<.0001	1.67 (1.66-1.68)	<.0001
	Community income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.06 (1.06-1.06)	<.0001	1.10 (1.10-1.10)	<.0001	1.18 (1.17-1.18)	<.0001	1.16 (1.15-1.16)	<.0001
		Q3	1.24 (1.23-1.24)	<.0001	1.25 (1.25-1.26)	<.0001	1.71 (1.70-1.73)	<.0001	1.72 (1.71-1.73)	<.0001
Rural	Korean income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.07 (1.06-1.07)	<.0001	1.05 (1.04-1.06)	<.0001	1.13 (1.11-1.14)	<.0001	1.12 (1.11-1.14)	<.0001
		Q3	1.14 (1.13-1.15)	<.0001	1.32 (1.31-1.33)	<.0001	1.48 (1.46-1.50)	<.0001	1.57 (1.55-1.59)	<.0001
	Community income level	Q1	Reference		Reference		Reference		Reference	
		Q2	0.94 (0.93-0.94)	<.0001	1.00 (0.99-1.00)	0.6250	1.00 (0.98-1.01)	0.4675	1.01 (0.99-1.02)	0.3533
		Q3	1.07 (1.06-1.08)	<.0001	1.16 (1.16-1.17)	<.0001	1.35 (1.33-1.37)	<.0001	1.80 (1.78-1.82)	<.0001
Women										
Urban	Korean income level	Q1	Reference		Reference		Reference		Reference	
		Q2	1.10 (1.10-1.10)	<.0001	1.15 (1.14-1.15)	<.0001	1.09 (1.09-1.10)	<.0001	1.11 (1.11-1.12)	<.0001
		Q3	1.31 (1.31-1.31)	<.0001	1.35 (1.34-1.35)	<.0001	1.54 (1.53-1.54)	<.0001	1.58 (1.57-1.59)	<.0001
	Community income level	Q1	Reference		Reference		Reference		Reference	
	Q2	1.17 (1.16-1.17)	<.0001	1.15 (1.14-1.15)	<.0001	1.25 (1.25-1.26)	<.0001	1.17 (1.17-1.18)	<.0001	

	Q3	1.41 (1.41-1.42)	<.0001	1.33 (1.33-1.34)	<.0001	1.73 (1.72-1.74)	<.0001	1.69 (1.68-1.70)	<.0001
	Q1	Reference		Reference		Reference		Reference	
Korean income level	Q2	1.10 (1.09-1.11)	<.0001	1.10 (1.10-1.11)	<.0001	1.22 (1.21-1.23)	<.0001	1.21 (1.20-1.23)	<.0001
	Q3	1.34 (1.33-1.35)	<.0001	1.38 (1.37-1.38)	<.0001	1.68 (1.66-1.69)	<.0001	1.65 (1.63-1.66)	<.0001
Rural	Q1	Reference		Reference		Reference		Reference	
	Q2	1.04 (1.03-1.05)	<.0001	1.03 (1.03-1.04)	<.0001	1.19 (1.17-1.20)	<.0001	1.28 (1.27-1.30)	<.0001
Community income level	Q3	1.23 (1.22-1.24)	<.0001	1.27 (1.26-1.28)	<.0001	1.59 (1.57-1.60)	<.0001	1.65 (1.63-1.67)	<.0001

265 ^aAdj OR, adjusted odds ratio; ^bCI, confidence interval; adjusted for gender, age, education,
 266 job status, marital status, basic livelihood condition, smoking status, high-risk drinking, and
 267 physical activity.

268

269 Discussion

270 This is the first study in Korea to compare mental health inequality according to
 271 relative income at the national and community levels using the CHS during the COVID-19
 272 period. This study intended to provide basic data necessary for policy development to resolve
 273 mental health inequality caused by income gaps in the event of large-scale infectious diseases.

274 During the COVID-19 pandemic, although depression crude rates increased, perceived
 275 stress crude rates remained similar. In addition, regarding mental health inequality according
 276 to income level, even after adjusting for each independent variable, perceived stress and the
 277 experience of depression increased as income level decreased. Hall et al. [19] found that low-
 278 income groups had less access to resources for responding to COVID-19 and suffered more
 279 economic stress than high-income groups. These economic difficulties reportedly have a
 280 negative impact on daily life and mental health [19,40,41]. As a result of measuring perceived
 281 stress as income inequality at the national level, it decreased after the COVID-19 outbreak,
 282 while income inequality at the community level increased after the outbreak of COVID-19.
 283 When measuring inequality by income level, few previous studies have identified mental
 284 health inequality at the community income level. Moreover, in some cases, inequality due to

285 the income gap at the community level may be more affected than the income gap at the
286 national level. Aneshensel CS and Sucoff CA [42] and Mair C et al. [43] found that the
287 economic situation (income level), population composition, and characteristics of the
288 residential environment in the area of residence have an effect on depression symptoms. This
289 result is consistent with previous studies that used the relative income gap at the community
290 level as a measure of health inequality and as a significant indicator for identifying the
291 relationship between income and depressive symptoms [15,16].

292 In this study, perceived stress was more vulnerable in the low-income group compared
293 to the high-income group for both income levels. Experience of depression showed the same
294 results, While women and men in 2019 and 2021, respectively, were susceptible to
295 experiencing depression. The result of women mental health inequality observed in this study
296 was higher than that of men, consistent with the results observed by Almeida et al. [44].
297 However, after the COVID-19 pandemic, the findings that men experienced higher levels of
298 depression than women were contradictory.

299 Additionally, this study confirmed the regional characteristics (urban and rural areas)
300 related to changes in mental health inequality according to relative income levels during the
301 COVID-19 pandemic. The effect of relative income level on perceived stress rate was found
302 to be more pronounced in urban areas than in rural areas. On the contrary, the effect of
303 relative income level on the depression rate was found to be weaker and more vulnerable in
304 urban and rural areas, in terms of Korean and community income levels, respectively. This
305 lack of consistent results has been reported in previous studies, as the impact on mental health
306 inequality in urban and rural areas is conflicting [45-49]. In urban areas, social distancing is
307 strongly practiced because of the high number of infected people, which may increase mental
308 health inequality. Furthermore, mental health may be more vulnerable in rural areas because
309 of the lack of information, access, and social support. These results indicate that the relative

310 income level during the COVID-19 pandemic can be expected to have different effects on
311 mental health depending on regional characteristics; however, additional research needs to be
312 conducted in the future.

313 The limitations of this study are as follows. First, the perceived stress and experience
314 of depression used as outcome variables are values that record responses in the form of self-
315 report rather than medical diagnosis, which raises the possibility of bias. However, because
316 items most frequently used in national surveys were used, the possibility of comparison with
317 other studies related to this topic is high. Second, changes in direct mental health inequalities
318 across the subperiods of the COVID-19 pandemic were not identified. In Korea, the COVID-
319 19 pandemic has usually been divided into three periods: the initial epidemic, delta mutation,
320 and omicron epidemic phase. It is necessary to identify the difference in mental health
321 inequality according to the income gap within the detailed epidemic period because the
322 response strategies differ depending on the size of the epidemic and the impact of restrictions
323 on socioeconomic activities, such as social distancing. In addition, future studies will need to
324 address how inequality will change even after the end of COVID-19.

325

326 **Conclusions**

327 This study identified aspects of mental health inequality according to relative income
328 during the COVID-19 pandemic and changes in inequality according to two types of income
329 levels. This study indicated inequality in mental health according to income level and
330 differences based on gender and residential area. To alleviate mental health inequality,
331 income inequality should be improved, and mental health policies should be intensively
332 implemented, especially for socioeconomically unequal population groups.

333

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337

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