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Heterogeneity in the Adoption of COVID-19 Preventive Measures Among Adults in Ethiopia: A Cluster Analysis Approach

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Abstract

This study investigates the extent of heterogeneity in the adoption of preventive measures among adult individuals in Ethiopia. Utilizing a nationally representative cross-sectional survey conducted by the World Health Organization in 2021, encompassing 895 participants, we explore the varying patterns of preventive measure adoption. Hierarchical cluster analysis is employed to discern potential subgroups within the respondents based on their adoption of preventive measures. Subsequently, logistic regression analysis is applied to ascertain the factors associated with the identified group divisions. We identify two distinct groups characterized by their responses to nine preventive measures. Group 1 comprises the majority of respondents (87%) who exhibit lower frequencies of adopting preventive measures. In contrast, Group 2 consists of 13% of respondents who demonstrate a higher frequency of adopting preventive measures. The amalgamation of cluster analysis and logistic regression outcomes yields insightful implications for the profile of preventive measure adoption. Our logistic regression analysis delves into the determinants influencing membership in the identified subgroups. Notably, it uncovers that individuals with a higher educational attainment exhibit a 2.33-fold greater likelihood of belonging to Group 1, signifying their relatively lesser adoption of preventive measures. In conclusion, this study not only sheds light on the heterogeneity within the adoption of preventive measures among Ethiopian adults but also underscores the influence of education on the propensity to adopt such measures. The findings contribute to better understanding of the dynamics surrounding public health behavior in the context of a pandemic.

Keywords: *COVID-19, Cluster analysis, Ethiopia, Heterogeneity, Logistic regression, Preventive measures.*

Introduction

The emergence of COVID-19 marked a significant threat to global public health, presenting an unprecedented challenge due to its highly infectious nature [1, 2]. At the onset of the pandemic, with a lack of widely available vaccines in most nations, the imperative of adopting preventive measures to mitigate infection rates and curb the disease's propagation became evident [3]. As a response to this crisis, various countries, including Ethiopia, embraced public health strategies and measures as advocated by the World Health Organization (WHO) and governmental bodies. These encompassed strategies such as

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minimizing contact between infected and uninfected individuals, instituting early case identification and isolation, and advocating for comprehensive hygiene practices at both individual and communal levels [4].

Ethiopia, recognizing the gravity of the situation, took stringent measures to counteract the spread of COVID-19 and safeguard the well-being of its populace. Collaborative efforts between the Ministry of Health and the Ethiopian Public Health Institute were instrumental in launching a series of initiatives following the confirmation of the first COVID-19 case in March 2020. In alignment with global recommendations, the government emphasized the significance of fundamental preventive measures, including hand hygiene, mask-wearing, and social distancing, as primary safeguards against the virus. Moreover, the closure of educational institutions, restriction of large gatherings, and even the imposition of lockdowns were part of the strategy to curb transmission [5].

The COVID-19 pandemic underscored the importance of adopting fundamental preventive measures such as hand hygiene, mask-wearing, and social distancing as an essential approach at both individual and community levels [6]. Nevertheless, it is evident that the effectiveness of these preventive measures is heavily contingent on the extent to which the public adheres to them [4]. The significance of compliance with preventive measures to mitigate the impact of the pandemic is indisputable; however, observations have indicated a concerning reluctance to embrace these measures within the Ethiopian context [5]. Surveys reveal that adherence to COVID-19 preventive measures has been relatively low, with a study in Hossana indicating that nearly half of the residents did not adhere to these practices [7]. Correspondingly, a study conducted in Addis Ababa uncovered that approximately 40% of the community failed to adhere to recommended preventive practices [8]. An additional study conducted in the Oromia region reaffirmed the challenge of low adherence, with less than 10% of the community following COVID-19 safety guidelines [9].

Recognizing the significance of acquiring accurate knowledge regarding the uptake of COVID-19 preventive measures, as well as identifying the factors linked to less frequent adoption of these measures [10, 11], it becomes imperative to delve into these facets within the context of Ethiopia's adult population, an economically challenged developing nation. In light of the escalating importance of comprehending the individual attributes contributing to the heterogeneity in embracing and sustaining such behaviors [12], this study seeks to explore the diverse degrees of acceptance of COVID-19 preventive measures among the adult populace in Ethiopia.

This study contributes to the burgeoning body of literature addressing COVID-19 by elucidating the heterogeneous nature of individuals' uptake of public health prevention measures aimed at combating the virus. Notably, prior research examining the adoption of these measures largely overlooked this inherent diversity. The current study endeavors to bridge this gap by not only identifying the heterogeneity in adoption but also uncovering the determinants that underpin the varying degrees of adherence to these pivotal COVID-19 preventive measures. The outcomes of this investigation shed light on the factors influencing why certain individuals exhibit a higher propensity to comply with these essential measures than others.

Methods

Study Setting and Period

The study comprised 895 adults hailing from diverse cities and regions across Ethiopia, encompassing Addis Ababa, Afar, Amhara, Benishangul-Gumuz, Dire Dawa, Gambela, Harari, Oromia, Sidama, Somali, Tigray, and Southern Nations, Nationalities and People’s

Region (SNNPR). The study was conducted from May to June 2021.

Study Design, and Sampling Procedure

As such, the dataset is demonstrative of the broader Ethiopian populace. A cross-sectional, descriptive study was conducted to answer the proposed research questions. The study relied on a nationally representative cross-sectional survey conducted during the peak time of COVID-19 outbreak. A multi-country knowledge and practices survey for Ethiopia, commissioned by WHO in order to understand the drivers of non-adherence to COVID-19 preventive measures, provided specific information on relevant variables. In the survey, individuals who held a mobile phone and were 18 years of age or older were targeted. GeoPoll, a research organization specializing in mobile surveys, conducted the survey. The survey was guided by four specific objectives: (i) Assess individual perceived risk of contracting COVID-19 and perceived effectiveness of the recommended public health measures; (ii) Determine the factors hindering uptake and adherence to COVID-19 preventive measures; (iii) Determine the factors facilitating uptake and adherence to COVID-19 preventive measures and (iv) Identify strategies, community solutions, approaches and preferred, accessible communication channels and trusted sources of information on COVID-19.

Survey sample size estimation targeted individuals stratified by gender, age, and location. The sample size was determined and considered to be able to achieve 95% confidence level at 3.7% margin of error. The selection of sampling frame was developed using a two-stage stratified cluster sampling approach where in the first stage, primary sampling units and regions are selected using probability proportion to size (PPS) method. In the second stage, a random selection of GeoPoll random digit dialing design (RDD) mobile numbers were generated from a representative sample of 4,667 per country. The GeoPoll's survey team used RDD sampling approach to select respondents.

Data Collection Approach

The online survey process involved a total of 23,775 attempts to contact potential survey participants. From these attempts, 5,285 individuals were successfully reached, constituting 22% of the attempted calls. Out of those reached, 1,633 participants chose to partake in the survey, accounting for 31% of those who were contacted. Ultimately, 895 individuals completed the survey, making up 17% of those who successfully completed. During the survey, 706 participants did not finish or dropped out, amounting to 13% of those who were reached. The refusal rate among reachable participants was 69%, as 3,652 individuals declined to participate. Ineligibility was observed in only 32 cases, comprising 1% of reachable participants. A significant proportion of attempted calls, 18,490 participants, did not respond or could not be reached, constituting 78% of the total attempted calls. The quantitative survey data was collected using a structured questionnaire and administered using Computer Assisted Telephone Interviewing (CATI) method.

Statistical Analysis

A descriptive analysis was performed of all the data obtained, showing the absolute and relative frequencies of the qualitative variables and the mean values with their corresponding standard deviations in the case of quantitative variables. A comprehensive analysis was conducted on the collected data, presenting both absolute and relative frequencies for qualitative variables, and mean values alongside their corresponding standard deviations for quantitative variables.

To classify the participants of the study according to how they followed preventive measures against COVID-19, cluster analysis was used. Cluster analysis is a method for segmentation was used to identify homogenous

groups of observations called clusters [13-15]. In this study, the researcher wanted to segment respondents alongside COVID-19 preventive measures adoption responses as clustering variables. The use of cluster analysis to segment population according to preventive measures is well supported in literature [10]. The adoption response variables for nine measures were classified into different groups using hierarchical cluster analysis following the agglomerative method by average linkage presented by Kaufman & Rousseeuw (2009) [16], and Jain & Dubes (1988) [17]. It should be noted that *Average linkage* clustering uses the average similarity of observations between two groups as the measure between the two groups. According to Kaufman & Rousseeuw (1990), the average linkage method works well for many situations and is reasonably robust [16]. Since the numbers of clusters are not pre-specified, the optimum clustering solution was reached using the statistical stopping rules proposed by Calinski-Harabasz (1974) [18] and Duda-Hart rule [19]. According to Balakrishnan & Anand (2015), these stopping rules are statistical tests which check for the presence of underlying clusters within the data and the number of such clusters that can be identified [20]. The rule of thumb is to choose the cluster solution with the highest value for Calinski-Harabasz pseudo-F statistic and at the same time it has a combination of higher Duda-Hart index value and lower pseudo-T-squared value [20]. According to Mooi et al, (2018)[13], in practice, researchers should combine the Calinski-Harabasz (1974) [18], and Duda-Hart indices by selecting the number of clusters that yields a large Calinski-Harabasz, a large Je (2)/Je index, and a small pseudo-T-squared value. The results of the stopping rules are presented in Supplementary Table 1. In the table, it is evident that two clusters meet this criterion (highlighted) and therefore 2 groups were used to determine the COVID-19 preventive measures adoption profiles.

To comprehensively explore demographic disparities between the groups, a thorough analysis was conducted utilizing cross tabulations. Subsequently, a final binary logistic regression analysis was employed to thoroughly examine the correlation between cluster membership and various demographic [15]. This approach allowed for a comprehensive assessment of how demographic characteristics may be associated with the observed cluster classifications.

Result

Sociodemographic Characteristics

Table 1 summarizes the important sociodemographic features of research participants. The survey findings reveal that 57% of the sampled individuals fall within the age range of 18 to 34 years. Participants aged 35 to 44 constitute around 19%, while roughly 24% are aged 45 and above. The survey's participants had an average age of 34 years, indicating a predominantly youthful population in Ethiopia. In terms of gender distribution, over half (56%) of the sample are male. As indicated in Table 1, approximately 65% of the respondents have attained education beyond the secondary level, with around 23% having completed secondary education. Impressively, more than 85% of the respondents have either completed secondary education or pursued education beyond that level.

Most of the surveyed population reported being married, constituting over 60% of the participants. In terms of income distribution, 51% of respondents reported earning between 4200 and 16500 BIRR per month, while approximately 46% indicated working in their preferred occupations. However, a notable 22% of respondents reported being unemployed.

Regarding household characteristics, the average household consists of 3 females and 3 males, with a mean household size of 4. A significant proportion of households (60.6%) have children aged above 5 years, while a

substantial majority (81.6%) comprise adults under 60 years of age.

Table 1. Socio-demographic Characteristics of Survey Participants

Characteristics	**Freq/Mean**	**Percent/Std Dev.**
Average age	34.4	11.2
Age Group		
18-24	188	21.01
25-34	320	35.75
35-44	173	19.33
45+	214	23.91
Gender		
Female	391	43.69
Male	504	56.31
Education		
No schooling	34	3.8
Primary	69	7.6
Secondary	207	22.8
Post-secondary	584	65
Marital status		
Married	571	63.8
Unmarried	286	31.9
Divorced/Widowed	38	4.2
Income		
Rich	52	5.8
Average	456	51.0
Poor	387	43.2
Occupation		
Craftsman/shopkeeper/business owner	110	12.29
Employee	409	45.7
Farmer	50	5.59
Industrial worker	12	1.34
Middle manager/team leader	25	2.79
Retired	17	1.9
Senior manager/self-employed profession	77	8.6
Unemployed	195	21.6
Household characteristics		
Number of females	3.1	8.0
Number of males	2.9	8.9
Total household size	4.4	2.1
Children less than 5 years		
No	542	60.56
Yes	353	39.44
Other persons older than 60 years		
No	730	81.56
Yes	165	18.44

The COVID-19 Preventive Measures Adoption Profile

To protect the public and prevent the spread of COVID-19, the government has advised various public health measures and guidelines. Participants in the study were asked what types of preventive measures they had implemented and were using to safeguard themselves and their families. The popular preventive measures were using face masks or cloth covering when in public and washing hands with soap and running water. About 76% and 67% of males, and 86%, and 63% of females adopted these measures as their primary preventive measures. Surprisingly, one in two respondents adopted and practiced keeping social and physical distance and using alcohol-based hand sanitizer preventive measures to protect themselves and their families from COVID-19. Among preventive measures, about 82%, 58%, 54%, and 48% of adults aged 18 to 24 years accepted and practiced wearing face masks or cloth covering when in public, washing hands with soap and running water, maintaining social and physical distance, and Using alcohol-based hand sanitizer, respectively. At the same time, around 86% of older individuals used face masks as their primary preventive intervention (Table 2).

Table 2. Frequency and Proportion of Adopted COVID-19 Preventive Measures

Perceived measures	**Overall**	**Gender**		**Age group**			
		Male	**Female**	**18-24**	**25-34**	**35-44**	**45+**
	N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Overall	**895(100%)**	**504(100%)**	**391(100%)**	**188(100%)**	**320(100%)**	**173(100%)**	**214(100%)**
Washing hands with soap and running water	586(65%)	338(67%)	248(63%)	109(58%)	212(66%)	123(71%)	142(66%)
Using alcohol-based hand sanitizer	462(52%)	262(52%)	200(51%)	91(48%)	181(57%)	84(49%)	106(56%)
Using face masks or cloth covering when in public	717(80%)	381(76%)	336(86%)	155(82%)	243(76%)	134(77%)	185(86%)
Not touching mouth eyes and nose	164(18%)	105(21%)	59(15%)	20(11%)	61(19%)	40(23%)	43(20%)
Not shaking hands	202(23%)	116(23%)	86(22%)	32(17%)	78(24%)	48(28%)	44(21%)
Keeping social and physical	474(53%)	272(54%)	202(52%)	101(54%)	168(53%)	95(55%)	110(51%)

distance							
Staying at home	106(12%)	70(14%)	36(9%)	14(7%)	43(13%)	24(14%)	25(12%)
Limiting unnecessary travel	153(17%)	94(19%)	59(15%)	16(9%)	57(18%)	40(23%)	40(19%)
Disinfecting frequently touched surfaces	128(14%)	79(16%)	49(13%)	20(11%)	46(14%)	31(18%)	31(14%)

In Table 3 below, the number of observations in each cluster are presented. It is evident in the table that more than three quarters of the respondents who participated in survey (87%) are in group or cluster (1), and rest of the respondents are in group or cluster two (13%).

Table 3. Percentage Distribution Adoption Clusters

Clusters	**Freq**	**Percent**
1	776	86.7
2	119	13.3
Total	895	100

The results presented in Table 4 below show the mean differences in the two groups or cluster identified with respect to COVID-19 preventive measures. It is evident from the cluster analysis; 2 groups were identified. Group 1 included 776 respondents who took preventive measures less frequently, the mean values for the nine measures analysed ranging from 0.04 to 0.82. Group 2 included 119 respondents who took preventive measures most frequently, the mean values ranging between 0.61 and 0.92.

Table 4. Groups of Respondents Identified According to Preventive Measures Adopted

	Cluster 1		**Cluster 2**	
COVID-19 preventive measures	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Washing hands with soap and running water	0.61	0.49	0.92	0.28
Using alcohol-based hand Sanitizer	0.47	0.50	0.82	0.39
Using face masks or Cloth covering when in public	0.82	0.39	0.70	0.46
Not touching mouth eyes and nose	0.07	0.26	0.91	0.29
Not shaking hands	0.13	0.33	0.87	0.33
Keeping social and physical distance	0.48	0.50	0.84	0.37
Staying at home during COVID-19 pandemic	0.04	0.20	0.61	0.49
Limiting unnecessary travel	0.07	0.26	0.81	0.40
Disinfecting frequently touched surfaces	0.04	0.20	0.82	0.39

The logistic regression analysis results (Table 5) for the factors related to these 2 sub-groups revealed that respondents with higher level of education (OR = 2.33, 95% CI [1.015,5.352]), were statistically significantly more likely to belong to group 1 (took fewer preventive measures) while the poor (OR=0.361, 95% CI [0.107,1.212]) were less likely to belong to group 2 (took more preventive measures) and results too are statistically significant. This means that the rich are less likely to adopt COVID-19 preventive

measures as group while the poor are less likely to take up more preventive measures.

Table 5. Logistic Regression

Variables	Odds ratio	St.Err.	t-value	p-value	95% CI	Sig
Education level						
No education (Reference)	1.00	-	-	-	-	-
primary	1.528	0.775	0.84	0.404	[0.565,4.128]	-
secondary	1.571	0.689	1.03	0.303	[0.665,3.71]	-
Post-secondary	2.331	0.989	2	0.046	[1.015,5.352]	**
Marital status						
Unmarried (Reference)	1.00	-	-	-	-	-
married	0.754	0.173	-1.23	0.219	[0.481,1.183]	-
Age in complete years	0.999	0.01	-0.08	0.938	[0.981,1.018]	-
Household size	1.019	0.05	0.39	0.695	[0.927,1.121]	-
Gender						
Female (Reference)	1.00	-	-	-	-	-
MALE	0.84	0.17	-0.86	0.388	[0.565,1.248]	-
Income level						
Rich (Reference)	1.00	-	-	-	-	-
Average	0.488	0.3	-1.17	0.243	[0.146,1.628]	-
Poor	0.361	0.223	-1.65	0.099	[0.107,1.212]	*
Constant	9.661	8.179	2.68	0.007	[1.838,50.774]	***
*** p<.01, ** p<.05, * p<.1						

Discussion

Our study examined the relative impact of sociodemographic variables that influenced the adoption of COVID-19 preventative measures among Ethiopian participants during the pandemic. As a result, the national-level report will aid in improved strategic planning to address the multifaceted issue of COVID-19 related practice and acceptability. To understand the adoption profile of respondents in respect to COVID-19 preventive measures, the researcher tabulated the cluster generated variable and also computed the centroids of the clustering variables.

The computation of cluster centroids helped us to examine whether the final partition differentiates the data well. According to Mooi et al, (2018), the computation of cluster centroids is very important since it allows the researcher to understand whether the clusters are truly distinct [13]. The results confirmed the distinctiveness of the clustering results. Based on this, the study analyses identified two groups based on nine adoption preventative measures responses: Group 1 contained the majority of respondents (87%) who took preventive measures less frequently, while Group 2 included 13% of respondents who took preventive measures more frequently. Several earlier studies conducted in Ethiopia revealed a poor degree of implementation of COVID-19 recommended safety measures [21, 22]. Likewise, Matovu et al (2021) reports low level of adoption of COVID-19 preventive Measures, in Uganda during the lockdown time [23].

Furthermore, the cluster analysis for the COVID-19 adoption profile results combined with logistic regression have significant implications. The logistic regression analysis focused on factors related to the two identified sub-groups. It revealed that respondents with a higher level of education had a 2.33 times higher likelihood of belonging to group 1, which indicates that they took fewer preventive measures against COVID-19. We observed a

higher literate rate of survey respondents with 65% (n=584) completed secondary school. This achievement is particularly noteworthy for a developing African country. It's remarkable to observe such high levels of education in an environment where, by 2021, 54% of individuals had completed primary school and 52% of adults were literate [24]. However, in terms of safety measure acceptance and adoption, our findings are consistent with Alagili, and Bamashmous's (2021) report, which found that respondents with the highest levels of education are less likely to adopt COVID-19 preventive behaviors than those with lower levels of education [25]. Moreover, another study revealed that education level has a moderating roles in inducing preventive actions [26].

On the other hand, the analysis showed that individuals in a lower socio-economic status (the poor) had a lower likelihood (OR = 0.361) of belonging to group 2, which suggests that they were less likely to adopt more preventive measures against COVID-19. In addition, the result indicate that wealthier individuals were less inclined to adopt COVID-19 preventive measures, while the less privileged (the poor) were less likely to adopt more extensive preventive measures. Similar to previous studies, education and income which are primary indicators of socioeconomic status drive adoption and adherence to public health preventive measures [10, 11, 25]. Numerous investigations consistently highlight a concerning trend: individuals with lower levels of education and those positioned at the lower rungs of the socioeconomic ladder encounter notable challenges in adhering to essential public health protocols amidst the COVID-19 pandemic.

This observed phenomenon can be attributed to several interconnected factors. Notably, groups with diminished socioeconomic status often exhibit lower health literacy levels, making it more difficult for them to comprehend and enact recommended preventive measures effectively [27]. Furthermore, these groups frequently grapple with barriers related to accessing critical information provided by public authorities. The limited availability of commonly used media outlets such as newspapers, television, and radio compounds these challenges, contributing to their difficulties in staying informed and implementing the advised precautions [28]. Consequently, the intersection of socioeconomic status, health literacy, and accessibility underscores the urgent need for targeted interventions to ensure equitable adherence to COVID-19 preventive measures across all strata of society [29]. These findings further highlight that those who are most vulnerable – the poor and less educated – to the adoption of COVID-19 preventive measures in developing countries which may need further help in understanding the need for and importance of public health prevention. This information is crucial for public health policymakers and authorities to tailor appropriate interventions and strategies for different socio-economic groups to effectively combat the spread of COVID-19.

Conclusion

Our study found that wearing face masks or cloth coverings in public, as well as washing hands with soap and running water, were the most popular preventive methods among both male and female respondents. A few sociodemographic characteristics were shown to be significantly linked with the use of COVID-19 preventative interventions. High education status was the most important indicator, followed by family income. Furthermore, participants with less education are more likely than the rest of the study population to use COVID-19 preventive actions. As a result, the authority is recommended to develop appropriate risk communication strategies for the COVID-19 pandemic, as well as the efficacy of prevention

measures and guidelines, regardless of educational levels or economic groupings.

Conflict of Interest

We declare that there is no conflict of interest.

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