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Investigating age-related COVID-19 digital health literacy and sense of coherence among adolescents and young adults in schools across Northern Ghana

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Abstract

Introduction The empirical link between digital health literacy (DHL) and sense of coherence (SoC) has been extensively discussed in the literature. Yet, there seems to be limited evidence regarding the roles of age and depression status in the link between DHL and SoC of adolescents and young adults (AYAs), especially during the COVID-19 crises. This study investigated the interplay between age, DHL, SoC and psychological distress. Particularly, the study examined the following: (1) relationship between DHL and SoC, (2) moderating role of age in the relationship between DHL and SoC as well as (3) moderating role of depression in the relationship between DHL and SoC.

Methods The study used a cross-sectional survey to select 998 AYAs in secondary schools in Northern Ghana through questionnaire administration using a stratified sampling procedure.

Results Findings reveal that age was positively and significantly related to DHL and SoC. However, age failed to moderate the relationship between DHL and SoC. With the same level of DHL, students who exhibited depressive symptoms compared to those without, had lower levels of SoC regardless of their age.

Conclusions Although AYAs' DHL are likely to differ across different age brackets, this gap does not affect their rates of SoC and depression. Nonetheless, there is a need to improve DHL through regular standard training on internet search using basic audio-visual materials like laptops, smart phones, tablets, and lab computers for adolescent and young adult students. Additionally, school authorities, in collaboration with other stakeholders should develop student-centred cognitive-behavioural strategies aimed at reducing depressive symptoms in secondary school students who are at risk of depression in Northern Ghana.

Keywords Adolescents, Young adults, Age, Depression, Digital health literacy, Sense of coherence, School

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Introduction

Adolescence (ages 10–19 years) and young adulthood (ages 19 to 24) are crucial developmental periods characterized by physical, emotional, and intellectual changes, as well as changes in social roles, relationships, and expectations [1]. At their developmental stage, adolescents and young adults (AYAs) are vulnerable to overlapping mental health stressors and strains, such as peer pressure, drug use, and sexual risk behaviors [2, 3]. These vulnerabilities are usually accounted for by the high levels of academic demand, hostile school environment, school maladjustment, inadequate support from relevant stakeholders, and inadequate learning/instructional resources [4–7]. These concerns across the AYA population were further heightened by the sudden outbreak of the coronavirus pandemic [8–11], coupled with financial distress and/or poverty, including other structural disparities [12, 13].

The psychological consequences among AYAs have also been attributed to the COVID-19 “infodemic” (i.e., the influx of COVID-related information and misinformation on online platforms) [14–16]. The spread of COVID-19 news on social media was dominated by negative epidemic information [17–20], with several studies showing that frequent contact with COVID-19 news in the mainstream media was associated with higher levels of depression among AYAs in schools [17, 19, 21–23]. This adverse mental health outcome among AYAs has been found to be associated with school maladjustment [24] and poor academic and social life [6]. The individual’s ability to cope with stress is very important; with coping resources are both personally and socially derived.

Sense of coherence (SoC) is one of the substantial personal health protection and promotion resources, particularly amongst young adolescents which facilitates coping in stressful and difficult life situations like the COVID-19 crisis [25]. According to the Antonovsky’s salutogenic model [26, 27], SoC is described as a way of viewing life and how such perception serves as a buffer to deal with the various stressors of everyday life. SoC is an important personal health coping resource that enables people to manage stress, evaluate their external and internal resources, identify, and use those resources, and promote effective coping and adjustment [28, 29]. Previous research found that AYAs’ SoC is positively associated with perceived health quality and positive health outcomes such as superior mental health and sense of well-being [19, 30–32]. Particularly, SoC has been shown to be positively associated with quality of life and negatively related to depressive symptoms [33]. In pandemic situations like COVID-19, SoC was positively linked with searching and finding health-related information of

interest (i.e., what individuals are looking for), assessing the reliability of the information, evaluating/judging the relevance of the information, and selecting among all the information found [34].

Prior studies have revealed that AYAs have demonstrated inadequate capacity of searching, evaluating and using information searched [35–37]. Thus, AYAs in schools might not perceive external stimuli as clear and ordered, which also calls for structural activities on high-quality information provision (inadequate comprehensibility). This inadequacy can negatively affect AYAs subjective well-being and mental health outcomes [38, 39]. Therefore, AYAs need adequate digital health literacy (DHL) to be able to understand and integrate COVID-19 related information, make sense of the COVID-19 infodemic and handle any stressful situation. DHL, which describes the capacity to access, understand, evaluate, and apply health information from electronic sources [40, 41], entails the knowledge, competence, and skills of an individual to attain, process, communicate and comprehend health information and services to promote and improve personal and community health through effective health decisions [38, 42, 43]. DHL is considered part of the ‘general resistance resources’ (GRRs) in SoC for countering potential life threats [44]. Extant investigators have identified that COVID-19 DHL positively reinforces SoC among AYAs and promote their well-being amidst the COVID-19 pandemic [34, 45]. For example, Zakar et al. [34] established that high COVID-19 DHL was positively associated with SoC among university students in Pakistan, with similar findings being reported in China [45].

Several studies indicate that the age of in-school adolescents is associated with their COVID-19 DHL with varying outcomes in AYAs, particularly at the university level [46–49] and SoC [50]. For example, significant differences in age were found among Hispanic university students, with those younger than 22 years exhibiting lower levels of COVID-19 DHL compared to those aged 22 years or older [48]. However, a negative significant association between age and COVID-19 DHL was discovered in Korea [46]. Other studies like that of Reick and Hering [51] found no correlation between health literacy and the student age during the COVID-19 pandemic. Regarding SoC, it has been shown that age is significantly associated with SoC, with young adults in Indonesia having higher SoC compared with middle and older-aged adults [50]. Findings from these previous studies have revealed inconsistent results in terms of the relationship between age, DHL and SoC during the COVID-19 pandemic. Besides, very little is known regarding the role of age in the relationship between COVID-19 DHL and SoC.

Substantial research has also established an inverse relationship between AYAs depression, DHL, and SoC. However, the moderating role of depression in the relationship between DHL and SoC is yet to be accounted for in previous studies. A study in Greece, for example, found that perceived depression is negatively associated with DHL among young adolescents [52]. Other scholars in China also discovered that health literacy is negatively associated with depression [45]. Similar findings have been reported in Vietnam [38, 39]. With reference to the relationship between SoC and distress-related variables, numerous studies have shown a negative association in Germany [53], Poland [54], Sweden [55], Norway [32], Spain [56], Japan [57, 58], and Israel [59, 60]. Given the relationship between AYAs' depression, DHL, and SoC, this study hypothesized that depression would moderate the relationship between DHL and SoC.

Further, AYAs in schools within the Northern regions are highly vulnerable to mental health problems (i.e., depression, stress, anxiety) [61–64], coupled with prevalent inadequate COVID-19 DHL [65], may face challenging circumstances due to low socio-economic status, poverty, poor parental support and control, including poor school environment [13,66–68]. Given the growing evidence of worsening mental health and increased levels of psychological distress, emotional isolation, depression, and anxiety amongst AYAs, it is imperative to understand their personal health coping resources (i.e., SoC) and how they seek, understand, appraise, and apply health information during the pandemic. AYAs in schools must make sense of COVID-19, rather than perceive the situation as something inexplicable or unmanageable to ensure good quality of life. AYAs' capabilities, such as their SoC, health literacy and health knowledge might help them to cope with challenges related to the pandemic. However, at present, there is limited evidence regarding the roles of age and depression status in the link between COVID-19 DHL and SoC of AYAs, especially during the COVID-19 crises. This study investigated whether the age-related COVID-19 DHL gap can predict SoC and depression levels. Specifically, the study examined the (1) relationship between COVID-19 DHL and SoC, (2) moderating role of age in the relationship between COVID-19 DHL and SoC, and (3) moderating role of depression in the relationship between COVID-19 DHL and SoC.

Methods and materials

Study participants

This research was carried as part of the global COVID-HL network (<https://covid-hl.eu/>). The cross-sectional survey design was employed to sample 998 secondary

school students from the Northern part of Ghana using the stratified sampling method. Originally, 1200 students were the target participants. However, only 998 valid responses (i.e., 83.17% response rate) were received and processed for this study. The Northern region was demarcated into two zones and used as strata. Following this classification, five secondary schools within the zones were randomly selected using the Table of Random Numbers methods. Within the schools, systematic sampling technique was used to select individual students. Participants were males ($n=514$, 51.5%), females ($n=457$, 45.8%) and diverse ($n=27$, 2.7%), with their ages ranging from 14 to 25 years. Majority of the participants were 19 years old ($n=273$, 27.4%), followed by the 18 years old ($n=252$, 25.3%) and 20 years old ($n=141$, 14.1%). The eligibility criteria included: (1) informed consent provided by parents for students who were below 18 years, and (2) participants should be officially enrolled in the sampled school and willing to be part of the research.

Study measures

Digital health literacy

Participants completed the Digital Health Literacy Instrument (DHLI), which was originally designed and calibrated by [41] and later Dadackinski and colleagues adapted the instrument to the COVID-19 context [66]. Dadaczynski et al. [66] designed the DHLI by selecting and modifying items from the original scale by van der Vaart and Drossaert [41]. Dadaczynski and colleagues adopted robust factor analytical approaches to test the applicability of the DHLI using different population from different countries. Following the initial validation, the instrument has been widely utilised and validated across several geographical boundaries [53, 67], including Africa [68]. Though the instrument has five dimensions, one of the domains (i.e., protecting privacy) consistently showed low reliability estimates across several countries and populations [69]. Thus, it was excluded from this study. The 4 remaining subscales of the DHL include: (i) searching for information online, (ii) adding self-generated content, (iii) assessing the reliability of online information, and (iv) determining the relevance of online information on a scale ranging from 1 (very difficult) to 4 (very easy). The participants were required to rate their level of literacy in terms of their ability to search, evaluate and understand COVID-19 related information on the internet. The Cronbach Alpha reliability coefficient values for the DHLI were deemed acceptable since all the dimensions had values greater than 0.70. The DHLI, in its current

form (i.e., 4-scale), has been psychometrically validated cross-culturally [53]. Higher scores on this measure depict higher levels of DHL and vice versa. The DHL scale is not under license.

Depression

The 5-item unidimensional World Health Organisation (WHO-5) well-being index was used to screen depression tendencies among participants [70]. The scale ranges from 0 (“at no time”) to 5 (“all of the time”). Some of the items on the scale are “I have felt active and vigorous”, “I have felt cheerful and in good spirit” and “I woke up feeling fresh and rested”. Scores are measured based on the responses provided by each participant. After calculating a sum score for each participant, the sum was multiplied by 4 to get a composite figure from 0–100. For the purposes of screening for depression, lower scores (<50) are indicative of depressive symptoms and higher values on the scale represent a sufficient wellbeing of the participants. The WHO-5 well-being index has been deemed an appropriate instrument for screening depression [71–73] and its divergent and convergent validity has been fairly established in Ghana [74]. Respondents were instructed to provide responses concerning their wellbeing during the COVID-19 pandemic lasting two weeks. The reported Cronbach Alpha reliability estimate was 0.75. The WHO-5 measure is an open source instrument that can be used for research purposes and thus, not under any license.

Sense of coherence

Participants’ sense of coherence (SoC) was measured using 9-item scale [75] to generally examine current living situations during the COVID-19 pandemic. The instrument has three main subscales, namely: comprehensibility (4-items), manageability (2-items) and meaningfulness (3-items) measured on a 7-point Likert scale ranging from 0 to 6. The instructional text require the respondents to assess their current life situation during the pandemic and the extent to which they felt burdened by it. A previous study reported a Cronbach alpha coefficient of the scale to be 0.86 [76]. In this study, the McDonald Omega (ω) reliability estimate of 0.81 was found. Higher scores on the SoC scale show sufficient SoC whereas lower values depict lower levels of SoC. The SOC scale is not under license for research purposes.

Procedure and ethics

Having obtained institutional ethical approval from the University of Education, Winneba, a reference number DAA/P.1/Vol.1/39 was obtained. Further approval was

sought from headmasters of the senior high schools involved in the study. All methods and standard procedures were carried out in accordance with relevant guidelines and regulations under the 6th edition of the Declaration of Helsinki. All participants were recruited from the schools. Ghana, like most African countries, is a multilingual nation that uses between 45 and 60 indigenous languages. English language has become a compulsory subject from the basic schools to the secondary schools and it is the medium of instruction throughout all levels of education. All public examinations are set in the English language [77]. Accordingly, the questionnaire was designed in the English language and data were collected via the same language.

Twelve research assistants were voluntarily employed and trained to assist in the data collection exercise. These research assistants were given a thorough briefing about each item on the questionnaire to enable a smooth administration of the survey instrument. The recruitment process began by establishing a good rapport between the researchers, research assistants, staff and students at the various schools targeted for the study. The researchers explained the rationale of the study to students and their teachers. Students who were willing to be part of the research were then asked to sign informed consent forms whilst those who were not ready to be involved were free to decline their participation. Informed consent, parental consent and child assent were solicited from adolescents 18 years or above and children below 18 years, respectively, using a verbal and written agreement. Ethical considerations addressed included anonymity and confidentiality whilst ensuring that all COVID-19 safety protocols were duly adhered to. The paper-based survey instruments were administered to students face-to-face with the help of the research assistants to respond to during the free periods on the school’s timetable. Participants spent about 15 min answering the survey instrument after which all the answered questionnaires were collected, sealed in big brown envelopes, and given to one of the researchers for safe keeping. The survey was carried out from August to November, 2021.

Statistical analysis

The data analysis started with preliminary checks on the data, which were screened and cleaned accordingly. The screening and cleaning were done by running simple frequency-percent, mean-standard deviation, and minimum–maximum statistics for the items. Inspections were carried out and some data entry errors were corrected by referring back to the hard-copy of the questionnaire. Some of the questionnaires were

also randomly sampled and the responses were cross-validated with the inputs in the SPSS. No outliers were recorded. Out of the 1032 cases, only 998 of them qualified to be processed for the analysis because (a) some of the cases did not have any information on the demographic variables (i.e., age and gender), (b) some respondents failed to provide responses on a whole section. For example, some participants did not provide any information on the COVID-19 DHL section of the instrument. The rest of the 998 cases did not have any missing data.

Descriptive statistics of the variables were studied to understand the relations existing among the variables, the distribution of the data, their means and standard deviations. To address the objective of establishing the relationship between DHL and SoC, a standard multiple regression analysis was conducted. Further, a series of moderation analyses were performed to examine the moderating roles of age and depression levels in the relationship between DHL and SoC. The analyses were conducted using SPSS (version 25, International Business Machines (IBM) Incorporation, New York) with further analysis performed using PROCESS macro developed by [78]. Model 1 of the PROCESS add-on package was used to fit the moderation model using 5000 bootstrap samples. For the moderation analysis, the bootstrap confidence interval (CI) was used for the interpretation of the results; the CI is not expected to include zero for the results to be significant.

Results

Preliminary analysis

The study focused on four major variables; DHL, SoC, depression level and age. The descriptive statistics of these variables were explored, including the correlations (parametric), mean and standard deviation as well as the skewness estimates associated with the variables (see Table 1 for the details).

The outcome of the descriptive analyses showed that DHL was positively and significantly associated with SoC ($r=0.305$, $p<0.001$), depression level ($r=0.318$, $p<0.001$), and age ($r=0.053$, $p<0.05$) (see Table 1). Further, higher levels of depression were also found to be associated with lower levels of SoC ($r=0.220$, $p<0.001$). Age was positively related to SoC ($r=0.067$, $p<0.05$). Age was not significantly related to depression levels. The skewness estimates for the variables were within an acceptable range.

Relationship between DHL and sense of coherence

The relationship between DHL and SoC was examined while controlling for age. Accordingly, a multiple linear regression analysis was performed to establish the link between the sub-domains of DHL and SoC, using age as a covariate. The tolerance and VIF values showed that there were no issues of multicollinearity. The Durbin Watson value was 1.54, which was also within the acceptable range, signifying the absence of autocorrelation. Table 2 presents the details of the analysis outcome.

Table 1 Correlations, Mean and SD, and Skewness of variables

Variables	Mean	SD	Skew	DHL	SoC	DEP
Digital Health Literacy (DHL)	2.50	.65	.188	1		
Sense of Coherence (SoC)	23.75	9.74	1.82	.305 ^a	1	
Depression (DEP)	43.78	26.97	.29	.318 ^a	.220 ^a	1
Age	18.89	1.88	.67	.053 ^b	.067 ^b	-.044

^a Correlation is significant at the 0.01 level (2-tailed)

^b Correlation is significant at the 0.05 level (2-tailed)

Table 2 Regression parameters for the link between DHL and SoC with age as covariate

Model		B	Std. Error	Beta (β)	t	p	Toler	VIF
1	(Constant)	7.068	3.143		2.249	.025		
	Searching information	.941	.460	.088	2.043	.041	.494	2.024
	Adding self-generated content	1.784	.474	.167	3.761	.000	.461	2.167
	Evaluating information reliability	.453	.484	.041	.936	.350	.482	2.076
	Determining information relevance	1.411	.403	.109	3.498	.000	.943	1.060
	Age	.286	.157	.055	1.824	.068	.991	1.009

Criterion Variable: Sense of Coherence

Model 1: $F(5, 993) = 21.73$, $p < .001$, $R^2 = .100$

The outcome of the analysis showed that the model—with DHL sub-domains as predictors, SoC as criterion variable, and age as a covariate—was found significant, $F(5, 993) = 21.73, p < 0.001$. Further, it was discovered that DHL sub-dimensions explained 10% of the variance in SoC while controlling for age.

As presented in Table 2, all the sub-domains of the DHL, except for evaluating information reliability, significantly predicted SoC among the students. DHL related to adding self-generated content had the highest prediction to SoC, $\beta = 0.167, t = 3.761, p < 0.001$. This analysis was followed by determining information relevance, $\beta = 0.109, t = 3.498, p < 0.001$, and lastly, by searching information, $\beta = 0.088, t = 2.043, p < 0.001$.

The moderating role of age between DHL and sense of coherence

The study also examined whether age played a significant role in the existing positive relationship between DHL and SoC. Table 3 presents the outcome of the moderation analysis.

The model fit indices showed a significant model fit index with relatively less error, $F(3, 994) = 35.368, p < 0.001, MSE = 85.971$. Additionally, DHL and age failed to predict SoC. The predictors (i.e., DHL, age, and the interaction term) explained about 9.6% of the variance in SoC levels. Age failed to moderate the relationship between DHL and SoC, $B = 0.198, SE = 0.211, BootCI(-0.215, 0.611)$.

The moderating role of depression in the relationship between DHL and SoC

The study also examined the moderating role of depression in the relationship between DHL and SoC, while controlling for age. The results are shown in Table 4.

As presented in Table 4, depression level (i.e., depressed or non-depressed) significantly moderated the relationship between DHL and SoC, $B = 2.559, SE = 0.949, BootCI(0.696, 4.422), f^2 = 0.168$. This result was shown in the conditional effect analyses, where the relationship between DHL and SoC differed among students who exhibited depressive symptoms and those who did not. With the same level of DHL, students who were not depressed were likely to show higher levels of SoC compared to those who were depressed. This pattern of result is shown in Fig. 1 where the regression (depicting the relation between DHL and SoC) is steeper for non-depressed students and less steep for those who exhibited depressive symptoms.

Discussion

This study examined the link between DHL and SoC as well as the moderating role of age and depression status of AYAs in the relationship between DHL and SoC. It emerged that high levels of DHL were associated with high levels of SoC. This result means that AYAs with high ability and skills in searching for COVID-19 information and determining its relevance are likely to have a higher tendency of understanding their current situations and

Table 3 Moderation effect of age in the relationship between DHL and SoC

	B	SE	t	p	BootLLCI	BootULCI	f ²
Constant	16.705	10.272	1.626	.104	-3.453	36.863	.106
DHL	.776	3.972	.195	.845	-7.019	8.571	
Age	-.225	.546	-.411	.681	-1.296	.847	
Int_1	.198	.211	.939	.348	-.215	.611	

Int_1: DHL*Age; Criterion Variable: SoC; $F(3, 994) = 35.368, p < .001, MSE = 85.971; R^2 = .096$ (asterisk means interaction)

Table 4 Moderation effect of depression status in the relationship between DHL and SoC

	Indicators	B	SE	t	p	LLCI	ULCI	f ²
Moderation model	Constant	9.625	3.161	3.045	.002	3.423	15.827	.168
	DHL	2.678	.565	4.739	.000	1.569	3.787	
	W1	-2.357	2.551	-.924	.356	-7.363	2.649	
	Int_1	2.559	.949	2.695	.007	.696	4.422	
	Age	.303	.152	1.988	.047	.004	.602	
Condition effect	Depressed	5.237	.764	6.854	.000	3.737	6.736	
	Non-depressed	7.795	1.628	4.788	.000	4.600	10.991	

Predictor: DHL; Moderator: Depression status; Covariate: Age; Criterion: SoC

Model summary: $F(4, 993) = 41.69, p < .001, MSE = 81.55, R^2 = .144$

W1- Non-depressed; Int_1: W1*DHL (asterisk means interaction)

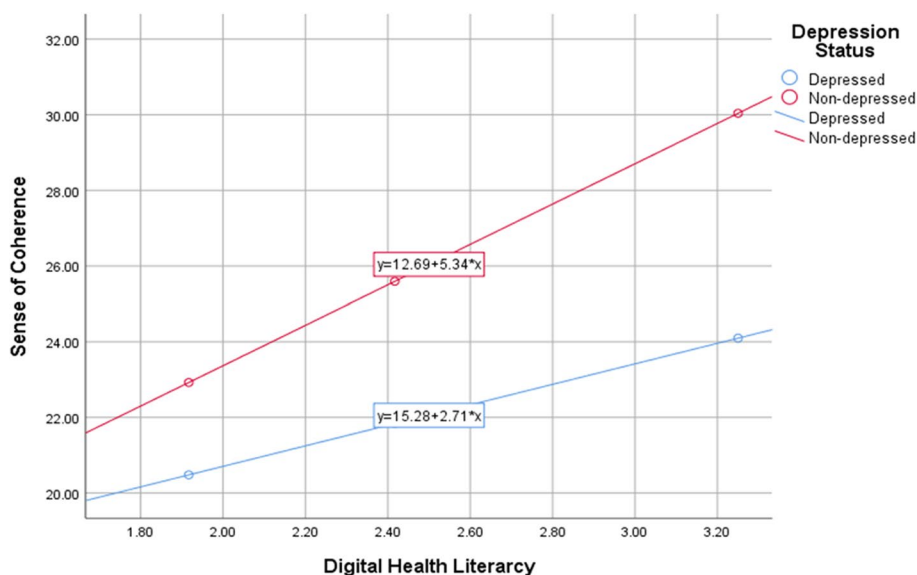


Fig. 1 Probing graph on the moderation effect of depression level of DHL and SoC

utilising available resources whether mental, spiritual, or social in dealing with challenges in their lives. This finding resonates well with usual expectations. Lindström and Eriksson [44] identified DHL as one of the general resistance resources in SoC for countering potential life threats. Understandably, digital literacy is embedded in SoC such that the successful use of SoC in dealing with the psychological consequence associated with COVID-19 requires, at least, some level of DHL, as confirmed in previous studies [34, 45]. The current findings suggest that AYAs’ capability to assess, understand, evaluate, apply, and generate health-related information via electronic sources are essential in order to comprehend the COVID-19 situation as explicable, manageable, and a challenge that required effective coping.

Further analysis indicated that the ability to evaluate the reliability of COVID-19 related information did not predict SoC. This finding suggests that the difficulty or ease with which AYAs use reliable COVID-19 related information does not solely relate to how well they can manage and cope with stressful life situations. In other words, AYAs ability to differentiate between right and wrong online COVID-19 related information might not be sufficient for them in terms of comprehending, managing and creating meaning in their current life situation. A key understanding of this situation is strongly connected to the characteristics of the study setting. While the availability of internet, internet gadget and socio-economic status are critical factors to developing SoC [25], it is important to stress that this present research was carried out in a poverty-prone setting [79, 80]. For example,

a student who has the ability to determine the reliability of COVID-19 related information but lacks internet (or internet gadget) may have challenges coping with the stressful situations associated with the disease. Also, a student who has the competence to evaluate the reliability of COVID-19 information yet do not have money to buy protective equipment (e.g., sanitizer, nose masks) would find it difficult coping with the stressful nature of the pandemic and the fear of perhaps contracting the virus. This observation is supported by some studies in Ghana which found that young and adults in secondary schools and universities who have sufficient monetary resources had better well-being and vice versa [81, 82]

The study also explored the moderating role of age in the relationship between COVID-19 DHL and SoC. Specifically, age did not moderate the DHL-SoC relationship. By implication, the age of AYAs does not necessarily matter regarding the association between COVID-19 DHL and SoC. Since age does not confound the COVID-19 DHL-SoC relationship, public health and health promotion interventions can be tailored to all AYAs in schools regardless of their ages. While there are no studies moderating age, some studies have explored the connection between age and DHL [46, 47, 49, 51], and between age and SoC [50]. Whereas some studies [51] reported no link between DHL and age, others have reported varying levels of age connection with both DHL and SoC [47, 49, 50]. The inconsistencies in the age-DHL(SoC) relationship could be methodologically differences. This present study, for example, included only secondary school students from a broader age bracket, although with the

same institutional background. Relative to other previous studies [50, 51], the age range was very narrow and could explain the why age did not significantly interact with DHL to affect SoC. There is the need for future studies to explore this age-DHL-SoC relationships using a wide age range to provide useful directions for health-based interventions.

The last objective assessed the moderating role of depression status in the link between COVID-19 DHL and SoC. With a very large magnitude of effect, depression moderated the association between COVID-19 DHL and SoC. The association was stronger for participants without depressive symptoms compared for those with depressive symptoms. With the advancement of COVID-19 DHL, SoC improved for all, although it was better for those without depressive symptoms relative to those exhibiting depressive symptoms. This finding implies that the prevalence of depression symptoms among students undermine their SoC even in their quest to acquire more skills in searching and evaluating COVID-19 related information through technology. Thus, students exhibiting depressive symptoms are likely to find themselves in a state of deteriorating well-being, characterised by extreme stress and anxiety, illogical reasoning, and mood disorders, among others. Such persons may not be in control and organised to be able to use their skills in searching and evaluating health-related information. Such individuals are likely to be devastated by their state of mental health which may affect their SoC. In partial support of this finding, some researchers have found low levels of COVID-19 DHL to be associated with high levels of depression [38, 39, 45, 52].

The direct link between the COVID-19 DHL and SoC appears to be spurious. While a weak positive relationship between COVID-19 DHL and SoC was found, the regression analysis also confirmed no significant effect of COVID-19 DHL on SoC when age was controlled. Interestingly, a significant effect of COVID-19 DHL on SoC was revealed when depression was controlled. The variations in the COVID-19 DHL-SoC relationship suggest that the link between the two variables is not a straightforward one. Hence, variables such as distress plays a key role when such relationships are examined. The results highlight the relevance of promoting activities or measures that could help reduce psychological distress among students.

Strengths and limitations

The cross-sectional survey and the subsequent statistical procedures used do not allow for a causal relationship between the variables. The measures used in this study were referenced to the COVID-19 situation. Hence,

the intensity of participants' responses is largely associated with their level of risk or exposure to the COVID-19 situation. Further, we did not perform any sociological analysis of these students because it has already been established by several reports in Ghana, including a World Bank report that the residents in the Northern regions are living in poverty [79, 80]. Additionally, only AYAs in secondary schools at the Northern zones of Ghana were involved in this research. Therefore, the applicability of findings to other geographical situations might be limited [83]. Notwithstanding, the current study significantly contributes to the body of knowledge on COVID-19 since it appears to be amongst the first to test moderating roles of age and depression in the relationship between DHL and SoC.

Practical implications

The present study have direct implications for health promotion and public health education. In the quest to promote the search for health-related information, particularly, with the use of technology, the attention of public health practitioners is drawn to the importance of providing psychological interventions aimed at reducing the depression levels of AYAs owing to the role depression status plays between COVID-19 DHL and SoC. Having established a direct link between COVID-19 DHL and SoC presupposes that intensive and continuous public education on COVID-19 DHL is warranted [84]. Importantly, public health practitioners may not necessarily have to coach AYAs in schools on SoC, rather, the intensification of education on COVID-19 DHL is more likely to lead to SoC. Additionally, public health practitioners should not assume that acquisition of information searching skills which enables one to comprehend, manage, and develop the meaning of one's mental, social, and spiritual resources for coping with life challenges is automatic for students as they age. Rather, AYAs in schools should be trained to acquire that information searching skills.

Conclusions

We investigated the interplay between age, COVID-19 DHL, SoC and psychological distress variables among adolescents and young adults in schools across Northern Ghana. The study highlights that although AYAs' COVID-19 DHL is likely to differ across different age levels, this gap is not severe enough to affect the rates of SoC and depression. It can be concluded that AYAs who exhibit depressive symptoms, irrespective of their age, are vulnerable to everyday life stressors even when they have a high level of COVID-19 DHL. There is a need to improve COVID-19 DHL through regular standard training on internet search using basic audio-visual materials

like laptops, smart phones, tablets, and lab computers for AYAs in schools. Besides, student-centered cognitive-behavioural strategies aimed at reducing depressive symptoms among this student population at risk of depression in Ghana could also be implemented and prioritized.

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Authors' contributions

J.E.H and F.Q. conceived the idea. F.Q. performed the analysis. M.S.S., F.A., E.K.A., F.Q., J.E.H., O.O., K.D., and T.S. prepared the initial draft of the manuscript. All authors thoroughly revised and approved the final version of the manuscript.

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Availability of data and materials

Anonymized data is available upon reasonable request through the corresponding author.

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of the the University of Education, Winneba, Ghana with document number DAA/P.1/Vol.1/39. All methods and standard procedures were carried out in accordance with relevant guidelines and regulations under the 6th edition of the Declaration of Helsinki. Informed consent, parental consent and child assent were solicited from adolescents 18 years or above and children below 18 years, respectively, using a verbal and written agreement.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

- WHO (2022). Adolescent and young adult health: Fact sheet. <https://www.who.int/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions>
- Eyiah-Bediako S, Quansah F, Omotosho JA, Hagan JE Jr. Assessment of peer pressure and sexual adventurous among adolescents in Ghana: the moderating role of child-rearing practices. *Soc Sci.* 2021;10:418.
- Park MJ, Scott JT, Adams SH, Brindis CD, Irwin CE Jr. Adolescent and young adult health in the United States in the past decade: little improvement and young adults remain worse off than adolescents. *J Adolesc Health.* 2014;55(1):3–16.
- Addadey JA, Quansah F, Mawusi RM, Ankoma-Sey RV. Trapped in the 'web': challenges of grade 9 pupils in choosing a course to pursue in senior high schools in Ghana. *Open Education Studies.* 2022;4:106–19. <https://doi.org/10.1515/edu-2022-0006>.
- Ankoma-Sey VR, Nsoh J, Quansah F. Phenomenological experiences of the girl-child in accessing technical education. *Am J Human Soc Sci.* 2019;4(4):498–505. <https://doi.org/10.20448/801.44.498.505>.
- Edjah K, Ankamah F, Domey E, Laryea JE. Stress and its impact on academic and social life of undergraduate university students in Ghana: a structural equation modeling approach. *Open Educ Stud.* 2020;2(1):37–44.
- Mulye TP, Park MJ, Nelson CD, Adams SH, Irwin CE Jr, Brindis CD. Trends in adolescent and young adult health in the United States. *J Adolesc Health.* 2009;45(1):8–24.
- Frimpong JB, Agormedah EK, Srem-Sai M, Quansah F, Hagan JE. Examining risk perception and coping strategies of senior high school teachers in Ghana: Does COVID-19-related knowledge matter? *COVID.* 2022;2(5):660–73.
- Hagan JE Jr, Quansah F, Ankamah F, Agormedah EK, Srem-Sai M, Frimpong JB, Schack T. Linking COVID-19-related awareness and anxiety as determinants of coping strategies' utilization among senior high school teachers in Cape Coast metropolis, Ghana. *Soc Sci.* 2022;11(3):137.
- Quansah F, Ankamah F, Hagan JE Jr, Srem-Sai M, Frimpong JB, Sambah F, Schack T. Development and validation of an inventory for stressful situations in university students involving coping mechanisms: an interesting cultural mix in Ghana. *Psych.* 2022;4(2):173–86.
- Quansah F, Hagan JE Jr, Sambah F, Frimpong JB, Ankamah F, Srem-Sai M, Seibu M, Abieraba RS, Schack T. Perceived safety of learning environment and associated anxiety factors during COVID-19 in Ghana: Evidence from physical education practical-oriented program. *Eur J Invest Health Psychol Educ.* 2022;12(1):28–41.
- Agormedah EK, Henaku EA, Ayite DM, Ansah EA. Online learning in higher education during COVID-19 pandemic: a case of Ghana. *J Educ Technol Online Learn.* 2020;3(3):183–210.
- Ahinkorah BO, Hagan JE Jr, Ameyaw EK, Seidu AA, Schack T. COVID-19 pandemic worsening gender inequalities for women and girls in Sub-Saharan Africa. *Front Glob Women's Health.* 2021;2:686984.
- Ahmad AR, Murad HR. The impact of social media on panic during the COVID-19 pandemic in Iraqi Kurdistan: online questionnaire study. *J Med Internet Res.* 2020;22(5):e19556. <https://doi.org/10.2196/19556>.
- Islam MS, Sarkar T, Khan SH, Kamal AH, Hasan SM, Kabir A, Yeasmin D, Islam MA, Chowdhury KI, Anwar KS, Chughtai AA. COVID-19-related infodemic and its impact on public health: a global social media analysis. *Am J Trop Med Hygiene.* 2020;103(4):1621.
- Orso D, Federici N, Copetti R, Vetrugno L, Bove T. Infodemic and the spread of fake news in the COVID-19-era. *Eur Soc Emerg Med.* 2020;27:327–8.
- Bendau A, Petzold MB, Pyrkosch L, Mascarell Maricic L, Betzler F, Rogoll J, et al. Associations between COVID-19 related media consumption and symptoms of anxiety, depression and COVID-19 related fear in the general population in Germany. *Eur Arch Psychiatry Clin Neurosci.* 2020;271:283–91. <https://doi.org/10.1007/s00406-020-01171-6>.
- Lee Y, Yang BX, Liu Q, Luo D, Kang L, Yang F, et al. The synergistic effect of social media use and psychological distress on depression in China during the COVID-19 epidemic. *Psychiatry Clin Neurosci.* 2020;74:552–3. <https://doi.org/10.1111/pcn.13101>.
- Li M, Xu Z, He X, Zhang J, Song R, Duan W, Yang H. Sense of coherence and mental health in college students after returning to school during COVID-19: the moderating role of media exposure. *Front Psychol.* 2021;12:3031.
- Yao H. The more exposure to media information about COVID-19, the more distressed you will feel. *Brain Behav Immun.* 2020;87:167–9. <https://doi.org/10.1016/j.bbi.2020.05.031>.

21. Chao M, Xue D, Liu T, Yang H, Hall BJ. Media use and acute psychological outcomes during COVID-19 outbreak in China. *J Anxiety Disord.* 2020;74:102248. <https://doi.org/10.1016/j.janxdis.2020.102248>.
22. Keles B, McCrae N, Grealish A. A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents. *Int J Adolescence Youth.* 2020;25:79–93. <https://doi.org/10.1080/02673843.2019.1590851>.
23. Olagoke AA, Olagoke OO, Hughes AM. Exposure to coronavirus news on mainstream media: the role of risk perceptions and depression. *Br J Health Psychol.* 2020;25:865–74. <https://doi.org/10.1111/bjhp.12427>.
24. Horgan A, Sweeney J, Behan L, McCarthy G. Depressive symptoms, college adjustment and peer support among undergraduate nursing and midwifery students. *J Adv Nursing.* 2016;72:3081–92. <https://doi.org/10.1111/jan.13074>.
25. Eriksson M, Lindström B, Antonovsky A. Sense of coherence scale and the relation with health: A systematic review. *J Epidemiol Commun Health.* 2006;60:376–81.
26. Antonovsky A. *Unraveling the mystery of health: How people manage stress and stay well.* San Francisco: Jossey-Bass; 1987.
27. Antonovsky A. The structure and properties of the sense of coherence scale. *Soc Sci Med.* 1993;36:725–33.
28. Antonovsky A. *Health, stress, and coping: new perspectives on mental and physical well-being.* San Francisco: Jossey-Bass Inc, Publishing; 1979.
29. Lindström B, Eriksson M. Salutogenesis. *J Epidemiol Commun Health.* 2005;59:440–2.
30. Braun-Lewensohn O, Idan O, Lindström B, Margalit M. Salutogenesis. Sense of coherence in adolescence. In: Mittelmarm M, Sagy S, Eriksson M, Bauer GF, Pelikan JF, Lindström B, Espnes GA, editors. *The handbook of salutogenesis.* Basel: Springer Nature; 2016.
31. Chu JJ, Khan MH, Jahn HJ, Kraemer A. Sense of coherence and associated factors among university students in China: cross-sectional evidence. *BMC Public Health.* 2016;16:336.
32. Moksnes UK, Espnes GA. Sense of coherence in association with stress experience and health in adolescents. *Int J Environ Res Publ Health.* 2020;17(1–12):3003. <https://doi.org/10.3390/ijerph17093003>.
33. Ångarne-Lindberg T, Wadsby M. Sense of coherence in young adults with and without experience of parental divorce in childhood. *J Divorce Remarriage.* 2011;52(5):309–21. <https://doi.org/10.1080/10502556.2011.585087>.
34. Zakar R, Iqbal S, Zakar MZ, Fischer F. COVID-19 and health information seeking behavior: digital health literacy survey amongst university students in Pakistan. *Int J Environ Res Public Health.* 2021;18:4009. <https://doi.org/10.3390/ijerph18084009>.
35. Chu-Ko F, Chong ML, Chung CJ, et al. Exploring the factors related to adolescent health literacy, health-promoting lifestyle profile, and health status. *BMC Public Health.* 2021;21:2196. <https://doi.org/10.1186/s12889-021-12239-w>.
36. Lin M, Sansom-Daly UM, Wakefield CE, McGill BC, Cohn RJ. Health literacy in adolescents and young adults: perspectives from Australian cancer survivors. *J Adolesc Young Adult Oncol.* 2017;6(1):150–8. <https://doi.org/10.1089/jayao.2016.0024>.
37. Sansom-Daly UM, Lin M, Robertson EG, Wakefield CE, McGill BC, Girgis A, Cohn RJ. Health literacy in adolescents and young adults: an updated review. *J Adolesc Young Adult Oncol.* 2016;5(2):106–18. <https://doi.org/10.1089/jayao.2015.0059>.
38. Nguyen HC, Nguyen MH, Do BN, Tran CQ, Nguyen TT, Pham KM, Pham LV, Tran KV, Duong TT, Tran TV, et al. People with suspected COVID-19 symptoms were more likely depressed and had lower health-related quality of life: the potential benefit of health literacy. *J Clin Med.* 2020;9:965.
39. Nguyen LHT, Vo MTH, Tran LTM, Dadaczynski K, Okan O, Murray L, Van Vo T. Digital health literacy about COVID-19 as a factor mediating the association between the importance of online information search and subjective well-being among university students in Vietnam. *Front Digit Health.* 2021;3:739476. <https://doi.org/10.3389/fgdth.2021.739476>.
40. Norman CD, Skinner HA. eHEALS: the eHealth literacy scale. *J Med Internet Res.* 2006;8:e27.
41. Van der Vaart R, Drossaert C. Development of the digital health literacy instrument: Measuring a broad spectrum of health 1.0 and health 2.0 skills. *J Med Internet Res.* 2017;19:e27.
42. Broucke SVD, Levin-Zamir D, Schaeffer D, Pettersen K, Guttersrud Ø, Finbråten H, de Arriaga MT, Vrdejlja M, Link T, Pelikan J. Digital health literacy in general populations: an international comparison. *Eur J Public Health.* 2020;30:5.
43. Sorensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, Brand H. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health.* 2012;12:80.
44. Lindström B, Eriksson M. From health education to healthy learning: Implementing salutogenesis in educational science. *Scand J Publ Health.* 2011;39(6_suppl):85–92.
45. Liu Y, Meng H, Tu N, Liu D. The relationship between health literacy, social support, depression, and frailty among community-dwelling older patients with hypertension and diabetes in China. *Front Public Health.* 2020;8:280.
46. Chun H, Park EJ, Choi SK, Yoon H, Okan O, Dadaczynski K. Validating the digital health literacy instrument in relation to COVID-19 information (COVID-DHL-K) among South Korean undergraduates. *Int J Environ Res Public Health.* 2022;19:3437.
47. Kühn L, Bachert P, Hildebrand C, Kunkel J, Reitermayer J, Wäsche H, Woll A. Health literacy among university students: a systematic review of cross-sectional studies. *Front Publ Health.* 2022;21(9):680999. <https://doi.org/10.3389/fpubh.2021.680999>.
48. Rivadeneira MF, Miranda-Velasco MJ, Arroyo HV, Caicedo-Gallardo JD, Salvador-Pinos C. Digital health literacy related to covid-19: validation and implementation of a questionnaire in Hispanic university students. *Int J Environ Res Public Health.* 2022;19:4092. <https://doi.org/10.3390/ijerph19074092>.
49. Vrdejlja M, Vrbovšek S, Klopčič V, Dadaczynski K, Okan O. Facing the growing COVID-19 infodemic: digital health literacy and information-seeking behaviour of university students in Slovenia. *Int J Environ Res Public Health.* 2021;18:8507. <https://doi.org/10.3390/ijerph18168507>.
50. Maulana H, Gumelar G, Irianda G. Do gender and age affect an individual's sense of coherence? An environmental psychology perspective of flood survivors in Indonesia. *IOP Conf Series Earth Environ Sci.* 2021;2021(623):012030. <https://doi.org/10.1088/1755-1315/623/1/012030>.
51. Reick S, Hering T. Health literacy of students. Results of an online survey at the Bochum health university (Germany). *Int J Health Prof.* 2018;5:44–52. <https://doi.org/10.2478/ijhp-2018-0007>.
52. Michou M, Panagiotakos DB, Lionis C, Costarelli V. Low health literacy and perceived stress in adults: is there a link? *Cent Eur J Public Health.* 2021;29(3):195–200.
53. Dadaczynski, et al. University students' sense of coherence, future worries and mental health: findings from the German COVID-HL-survey. *Health Promotion International.* 2022;37:daab070. <https://doi.org/10.1093/heapro/daab070>.
54. Zielińska-Więczkowska H, Sas K. Sense of coherence, self-perception of aging and the occurrence of depression among the participants of the university of the third age depending on socio-demographic factors. *Clin Interv Aging.* 2020;15:1481–91.
55. Carlén K, Suominen S, Lindmark U, Saarinen MM, Aromaa M, Rautava P, Sillanpää M. Sense of coherence predicts adolescent mental health. *J Affect Disord.* 2020;2020(274):1206–10.
56. López-Martínez C, Serrano-Ortega N, Moreno-Cámara S, del Pino-Casado R. Association between sense of coherence and mental health in caregivers of older adults. *Int J Environ Res Public Health.* 2019;16(1–10):3800. <https://doi.org/10.3390/ijerph16203800>.
57. Uchida H, Tsujino D, Muguruma T, Hino N, Sasaki K, Miyoshi M, Koyama Y, Hiraio K. Low sense of coherence is associated with anxiety among adults: Results based on data from all 47 prefectures of Japan. *Comprehens Psych.* 2018;86:131–6.
58. Yano K, Kase T, Oishi K. The effects of sensory-processing sensitivity and sense of coherence on depressive symptoms in university students. *Health Psychol Open.* 2019;6(2):2055102919871638.
59. Abu-Kaf S, Priel B. Vulnerabilities to depression and sense of coherence among Bedouin Arab and Jewish students: A test of a mediation model. *Int J Psychol Counsell.* 2012;4(3):31–40. <https://doi.org/10.5897/IJPC11.035>.
60. Abu-Kaf S, Khalaf E. Acculturative stress among Arab students in Israel: The Roles of sense of coherence and coping strategies. *Int J Environ Res Publ Health.* 2020;17(1–19):5106. <https://doi.org/10.3390/ijerph17145106>.
61. Hagan JE Jr, Quansah F, Frimpong JB, Ankamah F, Srem-Sai M, Schack T. Gender risk perception and coping mechanisms among Ghanaian university students during the COVID-19 pandemic. *In Healthcare.* 2022;10(4):687 MDPI.

62. Quansah F, Hagan JE Jr, Ankomah F, Srem-Sai M, Frimpong JB, Sambah F, Schack T. Relationship between COVID-19 related knowledge and anxiety among university students: Exploring the moderating roles of school climate and coping strategies. *Front Psychol.* 2022;13:820288.
63. Quansah F, Ankomah F, Agormedah EK, Abieraba RS, Srem-Sai M, Hagan JE Jr, Okan O, Dadaczynski K, Schack T. COVID-digital health literacy and subjective well-being of students in Ghana: mediation-moderation analyses. *Health Sci Rep.* 2022;5(6):1–10.
64. Hagan JE, Quansah F, Frimpong JB, Agormedah EK, Nugba RM, Srem-Sai M, & Schack T. Gender digital health literacy gap across age: A moderated moderation effect on depression among in-school adolescents in Ghana during COVID-19. *Psychol Schools* 2023;6(9). <https://doi.org/10.1002/pits.22942>
65. Sambah F, Quansah F, Srem-Sai M, Frimpong JB, Agormedah EK, Ankomah F, Hagan JE. Assessing secondary school students' digital health literacy, information searching behaviours, and satisfaction with online COVID-19 information in Northern Ghana. *Heliyon.* 2023;9(7):1–10. <https://doi.org/10.1016/j.heliyon.2023.e17936>.
66. Dadaczynski K, Okan O, Rathmann K. COVID-19 health literacy survey: University Students (COVID-HL-Survey). Questionnaire and scale documentation. Public Health Centre Fulda (PHZF) at the Fulda University of Applied Sciences & Interdisciplinary Centre for Health Literacy Research at Bielefeld University 2020. <https://doi.org/10.4119/unibi/2942920>
67. Martins S, Augusto C, Martins MR, Silva MJ, Okan O, Dadaczynski K, Duarte A, Fronteira I, Ramos N, Rosário R. Adaptation and validation of the digital health literacy instrument for Portuguese university students. *Health Promot J.* 2022;1:390–8. <https://doi.org/10.1002/hpja.580>.
68. Agormedah EK, Quansah F, Ankomah F, Hagan JE Jr, Srem-Sai M, Abieraba RSK, Frimpong JB, Schack T. Assessing the validity of digital health literacy instrument for secondary school students in Ghana: the polychoric factor analytic approach. *Front Digi Health.* 2022;4(968806):1–12. <https://doi.org/10.3389/fdgth.2022.968806>.
69. Lorini C, Velasco V, Bonaccorsi G, Dadaczynski K, Okan O, Zanobini P, Vecchio LP. Validation of the COVID-19 digital health literacy instrument in the Italian language: a cross-sectional study of Italian university students. *Int J Environ Res Public Health.* 2022;19:6247. <https://doi.org/10.3390/ijerph19106247>.
70. WHO. Wellbeing Measures in Primary Health Care: The DEPCARE Project; WHO Regional Office for Europe: Copenhagen, 1998.
71. Topp CW, Østergaard SD, Søndergaard S, Bech P. The WHO-5 well-being index: a systematic review of the literature. *Psychother Psychosom.* 2015;84:167–76. <https://doi.org/10.1159/000376585>.
72. Seb-Akahomen OJ, Okogbenin EO, Obagaye OM, Erohubie PO, Aweh BE. The 5-item WHO well-being index as a screening tool for depression in a population of doctors and nurses in Nigeria during the COVID-19 pandemic. *Open J Depres.* 2021;10(2):43–53.
73. Low KY, Pheh KS, Tan CS. Validation of the WHO-5 as a screening tool for depression among young adults in Malaysia. *Curr Psychol.* 2023;42(10):7841–4.
74. Quansah F, Hagan JE Jr, Ankomah F, Agormedah EK, Nugba RM, Srem-Sai M, Schack T. Validation of the WHO-5 well-being scale among adolescents in Ghana: Evidence-based assessment of the internal and external structure of the measure. *Children.* 2022;9(7):991.
75. Schumacher J, Wilz G, Gunzelmann T, Brähler E. The Antonovsky Sense of Coherence Scale. Test statistical evaluation of a representative population sample and construction of a brief scale. *Psychotherapie Psychosomatik Medizinische Psychologie.* 2000;50(12):472–82.
76. Leung AY, Parial LL, Tolabing MC, Sim T, Mo P, Okan O, Dadaczynski K. Sense of coherence mediates the relationship between digital health literacy and anxiety about the future in aging population during the COVID-19 pandemic: a path analysis. *Aging Ment Health.* 2022;26(3):544–53.
77. Susuawu C, Asiegbor J. The multilingual situation of Ghana and how multilingualism contributes to National Development. *Int J Innov Res Dev.* 2021;10(4):112–7. <https://doi.org/10.24940/ijird/2021/v10/i4/APR21036Page112>.
78. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. 2nd ed. New York: The Guildford Press; 2018.
79. Ofori-Boateng K, Bab I. Assessment of poverty levels in selected districts of rural Ghana. *J Poverty Invest Dev.* 2015;8:130–55.
80. World Bank. Ghana: Poverty Assessment; World Bank: Washington, DC, USA, 2020
81. Quansah F, Ankomah F, Agormedah EK, Ntumi S, Hagan JE, Srem-Sai M, ... & Schack T. A cross-sectional study of university students' pocket money variance and its relationship with digital health literacy and subjective well-being in Ghana. *Health Sci Rep.* 2023;6(2):e1095. <https://doi.org/10.1002/hsr2.1095>
82. Quansah F, Agormedah EK, Hagan JE, Frimpong JB, Ankomah F, Srem-Sai M, ... & Schack T. Subjective social status and well-being of adolescents and young adults in Ghanaian schools: conditional process analysis. *BMC Psychol* 2023;11(1):1–14. <https://doi.org/10.1186/s40359-023-01158-7>
83. Dzakadzie Y, Quansah F. Modelling unit non-response and validity of online teaching evaluation in higher education using generalizability theory approach. *Front Psychol.* 2023;14:1202896. <https://doi.org/10.3389/fpsyg.2023.1202896>.
84. Amoako I, Srem-Sai M, Quansah F, Anin S, Agormedah EK, Hagan JE Jr. Moderation modelling of COVID-19 digital health literacy and sense of coherence across subjective social class and age among university students in Ghana. *BMC Psychol.* 2023;11:337. <https://doi.org/10.1186/s40359-023-01334-9>.

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