

Contextualising the link between adolescents' use of digital technology and their mental health:
A multi-country study of time spent online and life satisfaction

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Abstract

Background: Evidence on whether the amount of children spend online affects their mental health is mixed. There may be both benefits and risks. Yet, almost all published research on this topic is from high-income countries. This paper presents new findings across four countries of varying wealth.

Methods: We analyse data gathered through the Global Kids Online Project from nationally representative samples of internet-using children aged 9 to 17 years in Bulgaria (n=1000), Chile (n=1000), Ghana (n=2060) and the Philippines (n=1,873). Data was gathered on internet usage on week and weekend days. Measures of absolute (comparable across countries) and relative (compared to other children within countries) time use were constructed. Mental health was measured by Cantril's ladder (life satisfaction). The analysis also considers the relative explanatory power on variations in mental health of children's relationships with family and friends. Analysis controlled for age, gender and family socio-economic status

Results: In Bulgaria and Chile, higher-frequency internet use is weakly associated with lower life satisfaction. In Ghana and the Philippines no such pattern was observed. There was no evidence that the relationship between frequency of internet use and life satisfaction differed by gender. In all four countries, the quality of children's close relationships showed a much stronger relationship with their life satisfaction than did time spent on the internet.

Conclusions: Time spent on the internet does not appear to be strongly linked to children's life satisfaction, and results from one country should not be assumed to transfer to another. Improving the quality of children's close relationships offers a more fruitful area for intervention than restricting their time online. Future research could consider a wider range of countries and links between the nature, rather than quantity, of internet usage and mental health.

Keywords: Internet use, digital technology, mental health, children, comparative research

Introduction

As children spend more and more time using the internet, in all parts of the world, it is important to understand whether and how this affects their mental health and well-being. While there is broad agreement that the time children spend on the internet can bring many benefits, equally there are legitimate concerns that it may bring negative impacts for some. Questions around children's internet use are part and parcel of today's public discourse in many countries, not only in Europe but also in parts of Asia, Latin America and Africa. This heightened concern comes at a time when many countries are making important steps towards more and better internet access for children, especially in low- and middle-income settings (Banaji, et al., 2018).

Understanding the impact of internet use on children's mental health and well-being is important from a child protection perspective; if significant harm occurs as a consequence of exposure, this needs to be considered when developing both child protection policies and national digitalization strategies. Early research on children's use of the internet suggested that time spent on the internet was related to a number of potentially harmful outcomes, such as increased likelihood of depression (Kraut et al., 1998, Kim et al., 2010), reduced social capital (Kraut et al., 1998; Putnam, 2000), reduced physical activity (Iannotti et al., 2010) or even addiction (Young, 1996). Influential research by Turkle (2011) suggested that children today are interacting more with their phone than with each other, arguing that this causes them to miss out on important social experiences. An assumption underpinning this research is that time spent online will detract from other activities thought to be more valuable, such as socializing face-to-face, reading books or exercising, though it may also substitute for time previously spent watching television, and though users may also socialize or read online. This is sometimes referred to as the displacement hypothesis, and it is further posited that harm caused by internet use is linearly proportional to exposure (Neuman, 1988).

The displacement hypothesis has received some support throughout the past two decades of research. While most early research on this topic used cross-sectional data, more recently some authors have examined repeated cross-sectional and longitudinal data, with results suggesting that increased use of social media is significantly associated with higher rates of suicide and depression (although see Heffer et al, 2019; Livingstone, 2018). However, there is still considerable debate in this field; although statistically significant negative effects have been observed in some large-scale datasets, other researchers argue that the size of these effects is so small as to be practically meaningless (Orben & Przybylski, 2019a; Orben & Przybylski, 2019b). These scholars, and others, have argued that we should look beyond screen time measures and instead consider what other factors more substantially influence children's mental health (Stiglic and Viner, 2019, Przybylski & Weinstein, 2017). Arguments have been made that the specific content, contacts and conduct children encounter online might be more relevant when trying to understand how internet use affects them (Livingstone, Haddon & Görzig, 2012). Analysing the effects of content, contact and conduct online is complicated by the fact that few datasets include

such indicators in any reliable or comprehensive way. The few datasets that contain such indicators tend to be highly focused on the online environment, lacking appropriate indicators for other factors that are important to child well-being, such as children's socio-economic situation, their family relationships or peer support networks. In particular, three recent longitudinal studies from Canada, Europe and the US did not find a significant direct impact of time children spend using digital technologies (social media, the internet, and texting) on their mental health (measured as depression and anxiety) (George, Russell, Piontak, & Odgers, 2018; Heffer, Good, Daly, MacDonell, & Willoughby, 2019; Hokby et al., 2016). In fact, one study found evidence of reverse causation where greater depressive symptoms predicted more frequent social media use, albeit only among girls (Heffer et al., 2019). However, despite these recent findings, the public discourse around screen time continues to be driven by a moral panic rather than by a measured and evidence-informed perspective (Mullan, 2017; Ferguson, 2017).

The strength of any association between screen time and mental health may depend on the specific conceptualisation of mental health being considered. It has become common in the study of well-being to distinguish between positive functioning and mental health problems (e.g. Antaramian, Huebner, Hills & Valois, 2010; Bergsma, Have, Veenhoven & de Graaf, 2011). There are also more detailed subdivisions within each of these concepts – including components of positive functioning such as subjective and psychological well-being, and various more specific mental health difficulties such as depression, anxiety and behavioural problems. A series of studies in the UK (Booker, Kelly & Sacker, 2018; Booker, Skew, Kelly & Sacker, 2015; Kelly, Zilanawala, Booker & Sacker, 2019; McDool, Powell, Roberts, & Taylor, 2016; Rees, 2019) has demonstrated three key points: 1) there are generally significant associations between digital time use and mental health; 2) these associations are typically quite weak compared with the links between other factors and children's mental health; 3) and their strength varies according to the component of well-being under consideration.

Some research has identified differences in the associations between time spent online and mental health across sub-groups and also according to the timing of usage. For example, McDool et al. (2016) find that, in the UK, there are stronger negative associations for girls than boys. Relatedly, Przybylski & Weinstein (2017) find evidence, in a large sample of English adolescents, that the association between some aspects of technology use and mental health, while small, is stronger on weekdays than at the weekends.

A striking feature of the research literature on children's use of the internet is that it is almost exclusively based on data from children living in high-income countries, typically Europe and the United States. This is probably due to better availability of data and more resources available for researchers in these countries, and possibly due to earlier internet adoption as well. However, at a global level, the number of child internet users is already higher in low- and middle-income countries than in high-income countries (Livingstone, Carr, & Byrne, 2016). And while young internet users already outnumber adult users in most parts of the world, that difference is even more pronounced in low- and middle-income settings.

Taking a holistic view of the life of the child, the Global Kids Online network developed a research toolkit that enables researchers to study how children's online experiences influence and interact with their lives more broadly (Stoilova, Livingstone and Kardefelt-Winther, 2016). The toolkit was developed to address the dearth of evidence on children's online experiences globally, especially in low- and middle-income settings. The data generated provides researchers with a holistic perspective on children's lives and yields data that is well-suited to understand how online and offline factors interact (or not) in shaping children's lives and well-being, such as the relative effect of screen-time compared to other social, economic or family-level factors. Descriptive findings show that while gender differences in access and digital skills are small, especially in higher income countries, and that differences in the parental mediation of girls and boys are also fairly small, online activities do differ among girls and boys; there are also gender differences in exposure to online risk, though this varies considerably by country (Livingstone, Kardefelt-Winther, & Hussain, 2019).

To explore the impacts of the time children spend using the internet on their mental health and well-being in settings outside of Europe and the United States, we use some of the first ever nationally representative data on children's online experiences collected in four countries – Bulgaria, Chile, Ghana and the Philippines – with varying national wealth (from lower-middle to high), cultures (as regards customs, religion, language and parenting styles; Livingstone & Byrne, 2018) and internet penetration rates across four continents. Data were collected by national UNICEF offices and academics in each country using the Global Kids Online research toolkit.

We explore three research questions in this paper:

1. What is the association between the time children spend on the internet and their mental health?
2. Does this association differ by gender?
3. What is the relative importance of time spent online in influencing children's mental health compared to social or family factors?

In addition, we consider cross-national differences and compare the results to what has previously been found in research from Europe and the United States. This is particularly important because too often research conducted in Western countries is generalized to non-Western settings, which can be misleading (Banaji et al., 2018). Yet psychological theory should surely be context-sensitive and context-specific. This paper contributes new and unique insights into the psychology of internet use by analysing data from countries where traditionally there has been very little research on this topic.

Method

Data

Data were obtained from the database of the multi-national evidence generation programme Global Kids Online¹, led by UNICEF Office of Research and the London School of Economics and Political Science. Global Kids Online has been implemented in 18 countries in the global South to date, yielding data from nationally representative household surveys of internet-using children. The data used for this paper were collected at different points in time by individual national country teams (see Table 1). Details from each national study in terms of sampling and survey administration can be found in their respective national reports.² Comprehensive ethical protocols were developed by national teams to ensure compliance with national requirements, cultural considerations and UNICEF's internal policy for conducting ethical research with children. The survey received ethical approval from a relevant ethical board in each country.

In all countries, questionnaires were administered to children and one of their parents in the household, using computer-assisted personal interviewing tools. The interview was a mix of self-interviewing and interviewer-administered questions; sensitive or private questions were filled out in private by the child, while more general questions were filled out together with the interviewer. The parent and child were interviewed at the same time by two separate interviewers to ensure a greater degree of privacy during questionnaire completion, most often with a younger interviewer of the same gender as the child conducting the child interview. Consent was sought from parent and assent from the child in each household, with clear communication of the right to withdrawal from the interview, the right to have interview data deleted after the interview, procedures for data storage and retention, as well as national laws on mandatory reporting requirements. Child and parent were both provided with information about national support services, if they would like to speak with a professional following the interview.

INSERT TABLE 1 AROUND HERE

These four countries – Bulgaria, Chile, Ghana and the Philippines – were selected for the analysis based on availability of variables relating to the key research questions in the dataset, and because they represent children living on four different continents. The data were obtained from 1,000 internet-using children in each of Bulgaria and Chile, 2,060 in Ghana and 1,873 in the Philippines. The samples were nationally representative of children who use the internet and reasonably equally balanced across the age range, 9 to 17 years old, and by gender. In all countries the design of the sample was a random multistage cluster sample stratified by region, with a probability of selection proportionate to size. Within each enumeration area, random walk procedures were used for household selection. In each household selected, a random child (if more than one) between ages 9-17 was selected for interview. In Bulgaria the sampling was

¹ See www.globalkidsonline.net for information.

² See www.globalkidsonline.net/countries

combined with a quota of ethnicity. All statistical analyses control for age, gender and an indicator of family socio-economic status.

Measures

Mental health

The key dependent variable in the analysis is a measure of children's life satisfaction based on Cantril's ladder (Cantril, 1966). Children were asked to rate their current life on an 11-point scale where zero is labelled the 'worst possible life' and 10 is labelled the 'best possible life'. This measure is widely used in large-scale comparative surveys of adult and child well-being, such as the Gallup World Poll, the Health Behaviour in School-aged Children surveys and OECD's PISA surveys. Conceptually this question taps into the concept of positive well-being (Seligman & Csikszentmihalyi, 2000) and is viewed as a measure of the cognitive component of subjective well-being (Andrews & Withey, 1976; Diener, 1984). This approach is in accordance with the World Health Organization's (WHO) definition of mental health, as "*a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community*". That is, mental health is conceptualised as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.³

Levels of missing data for this variable were very low (below 1% in Bulgaria, Chile and Ghana. However, in the Philippines, around 11% of children did not answer this question. Children with missing data did not differ significantly from children who answered the question in terms of age or gender, but were more likely also to have missing SES data (see also below).

Mean life satisfaction scores and standard deviations (in brackets) were as follows – 8.47 (1.68) in Bulgaria; 8.25 (1.84) in Chile; 7.57 (2.05) in Ghana; and 6.86 (2.67) in the Philippines. It is not our intention in this paper to compare these levels of life satisfaction between countries.

There are, in any case, doubts about the cross-cultural comparability of mean life satisfaction scores (e.g. Diener, Oishi & Lucas, 2003). However, there is support (based on testing of multi-item scales of children's subjective well-being) for using such measures for comparing correlational and regression analysis across countries as we do in this paper (Casas, 2017).

Use of the internet

Children were asked a range of detailed questions about their use of the internet and, from this information, several summary measures were created for use in the analysis.

First, the survey asked how many hours children spent on the internet on an average day during the week and at the weekend. Response options were 'None', '30 minutes', and then number of hours up to '7 hours or more'. There was less than 2.5% missing data for these variables in Bulgaria, Chile and Ghana. In the Philippines, around 11% of cases lacked data for one or both variables. Cases with missing data did not differ significantly from cases with complete data on age, gender, SES or life satisfaction.

³ https://www.who.int/features/factfiles/mental_health/en/

We created a summary measure of estimated weekly hours by summing the weekday average multiplied by five and the weekend average multiplied by two. This represents an estimate with a ceiling because the maximum value that children could specify per day was ‘7 hours or more’ which was treated as 7.5 hours for the purposes of calculating the estimate. Histograms for this variable for each country are shown in Figure 1. The average estimated number of online hours was highest in Chile (mean=20.07, sd=14.5), followed by Bulgaria (mean=15.59, sd=10.55), the Philippines (mean=11.68, sd=12.35) and finally Ghana (mean=11.46, sd=10.37). Pairwise comparisons of these means (using a Bonferroni correction) were statistically significant for all pairs except Ghana and the Philippines. More than half of children (59%) used the internet for more than an average of two hours per day in Chile (59%), compared to 45% in Bulgaria, 27% in the Philippines and 26% in Ghana.

INSERT FIGURE 1 AROUND HERE

For the purposes of analysis we created an ordinal grouped variable from this estimate, based on 7-hour intervals. We also created similar variables with 5- and 10-hour intervals. Finally, for reasons discussed in the Analysis section, we also created a measure of the relative amount of time spent online within each country. Children were divided into five quintiles of time use on a country-by-country basis, using the total estimated weekly hours.

Relationships with family and friends

The survey included, in all four countries, three questions each about children’s relationships with their family (being helped, being listened to and feeling safe at home) and friends (receiving help, support and being able to talk about problems). Each question asked how children felt these aspects applied to them on a four-point scale from ‘Not at all true’ to ‘Very true’. There was no missing data for these variables in Ghana and less than 2% in Bulgaria. In Chile and the Philippines however, the level of missing data for one or more of these variables was around 23%. Checks were conducted on the characteristics of these children in terms of age, gender, SES and life satisfaction scores. In Chile, the only significant difference was that children with missing data were significantly younger mean (12.0) than children with complete data (13.2). In the Philippines, children with missing data were significantly more likely to be male (25% compared to 20% female) and to have lower life satisfaction (by around 0.5 points on the 10-point scale). The findings presented regarding the third research question should not therefore be regarded as fully representative of the population of children online in these two countries.

Prospectively it was envisaged that these sets of questions might form multi-item scales. However, the set of questions about family relationships in particular did not obtain satisfactory levels of reliability in all countries. Therefore, the items were entered into the analysis separately. For brevity they are shown in the main tables as interval variables (coded from 0 to 3); but the same regression models were run treating them as factor variables and it made little difference to the results.

Control variables

All analysis also includes children's age, gender and family socio-economic status (SES) as these are all known potential correlates with both time use and child well-being. Age was measured in years, gender was coded as boy or girl. There was only missing data on age for one case in Ghana and there was no missing data for gender. The SES variable was reported by parents and differed according to the country, based on the preferences of the national research team. While a standard measure for SES was tested in several Global Kids Online pilot surveys, this measure was not reliable in some countries and not feasible to ask in others due to cultural considerations. Therefore, each country uses a nationally validated measure, which has implications for cross-national comparability but respects national circumstances. In Bulgaria and the Philippines the SES variable was a measure of household income, while in Ghana it was a measure of social class calculated by summing questions related to ownership of household devices, cooking facilities, toilet type, water source, parent education and occupation, residential area and type of house. In Chile, the SES variable was constructed by summing indicators for parent income, parent education and parent occupation. In the Philippines there was a substantial amount of missing data for the SES variable due to participants' unwillingness to disclose this type of information, so missing values were treated as a category within the factor variable in order to avoid losing too many cases.

Analysis

Univariate statistics for each of the variables above are shown for each country in Table 2.

INSERT TABLE 2 AROUND HERE.

All analysis was conducted in Stata 14. It consists of a series of regression models, run separately for each of the four countries, driven by the research questions as discussed in more detail in the results section. All models within each country use the same number of cases (excluding missing data on any of the included variables) in order to aid comparability across models. Wald tests and the *suest* command were used to compare effects across regression models in the analysis for the first research question. The *testparm* command was used to test for interactions in the analysis for the second research question. A result described as statistically significant refers to a p-value of less than 0.05 unless otherwise stated.

The regression models use a single-item dependent variable of life satisfaction, with response values from 0 to 10. This is treated as an interval variable in the analysis. Previous research has indicated that there is little substantive difference in regression results using this type of life satisfaction variables whether one treats it as cardinal or ordinal (Ferrer-i-Carbonell & Frijters, 2004). However, the use of a single-item measure is a limitation of the analysis, and a psychometrically tested multi-item measure (e.g. Casas, 2017) would have been preferable.

To answer the first question, several different models were fitted in each country to explore the relationship between time spent online and life satisfaction, always controlling for age, gender

and SES. It is important to consider the association within the context of these variables because they are often associated with both time use and children's mental health.

The models used the information on time spent online in different ways as follows. First, we test separately the association of weekday and weekend use with life satisfaction. Second, we test the association of total estimated weekly online hours with life satisfaction, using the estimate as a grouped ordinal variable based on 7-hour intervals and also as a continuous variable. The purpose of the grouping was to assess the shape of the association, which may not be linear and may take different shapes in different countries. As a robustness check the analysis was also run with variables based on 3-, 5- and 10-hour groupings of internet use. Finally, we take a relative approach within countries, using the variable described earlier whereby children were divided into quintiles in each country based on estimated weekly hours of online use.

Thus we examine the association between time spent online using both absolute and relative measures. The absolute approach assesses the effect of a particular number of hours of time spent online, and is directly comparable across countries. The relative approach, on the other hand, focuses on whether children are 'low' or 'high' internet users compared to their peers within the same country. This approach may provide additional insights as it contextualises each child's usage within the distribution of time spent online typical for that country. To address the second research question, we conducted the above analysis with interactions between gender and the time use variable to test whether there are gender differences in the relationship between time spent online and life satisfaction. To address the third question we introduced into the regression models the variables regarding relationships with family and friends. We did this only for the absolute and relative measures of overall weekly time spent online as this is sufficient to address the research question. The rationale for this aspect of the analysis is to understand whether prior research only controlling for age, gender and socio-economic status might have overestimated the effect of time spent online on life satisfaction, as well as shed light on additional variables that need to be included when analysing the effect of children's internet use on their mental health.

Results

1. What is the association between the time children spend on the internet and their mental health?

The first two models (Model 1 and 2 in Tables 3 to 6) test the association between weekday and weekend time spent online respectively and life satisfaction. Charts of the predicted values of life satisfaction by time spent online (controlling for age, gender and socio-economic status) are shown in Figure 2. For weekday use, in Bulgaria and Chile children who were online for more hours had significantly lower levels of life satisfaction. In Bulgaria, for weekend use, high levels of use were associated with significantly lower life satisfaction than no use. In Chile and Ghana there was weak evidence of an inverted U-shape association with significantly higher life satisfaction for children who were online for one hour (Chile) and two hours (Ghana) compared

to those were not online. There were no significant overall associations between either weekday or weekend use in the Philippines, although some of the individual coefficients were individually significant. In all models with significant associations the added explanatory power (compared to a model with only the control variables) of the time use variable was small (no more than +3%). Additional tests were run to compare the associations of weekday and weekend use in each country. The only significant difference was in Chile where the weekend pattern, with the peak at around one hour of use, differed significantly from the weekday pattern.

INSERT FIGURE 2 AROUND HERE

INSERT TABLES 3 TO 6 AROUND HERE

The second step in the analysis was to run regressions with the summary variable of the estimated number of weekly hours online. This was done treating it as a continuous variable and as a grouped ordinal variable. A linear regression (Model 3 in Tables 3 to 6) treating the variable as continuous had a significant negative coefficient for time use in Bulgaria, Chile and Ghana but not in the Philippines. The same results were obtained treating time use as a grouped (7 hour) ordinal variable (Model 4). Predicted life satisfaction (taking account of control variables) using this variable are shown in the first column of Figure 3. There is visual evidence of declining life satisfaction with increasing online hours in Bulgaria and Chile; a more complex pattern with a possible inverted U-shape in Ghana; and no visual evidence of a trend in the Philippines. Due to the visual pattern in Ghana, regression models were run with a linear and quadratic term for the continuous time use variable. The quadratic term was statistically significant in Ghana but not in the other three countries. As a robustness check for the ordinal variable we ran the same analysis using 3-, 5- and 10-hour intervals. The broad conclusions were the same, with evidence of significant associations between time spent online and life satisfaction in Bulgaria, Chile and Ghana and not in the Philippines. The one exception was that with a 10-hour time interval there was no longer a significant association in Ghana, probably due to the limited granularity of the data. The added explanatory power of time spent online was quite small in most of these models, being largest (around +2.7% being for weekend use in Bulgaria and Chile).

INSERT FIGURE 3 AROUND HERE

The third step was to assess relative time spent online within countries (Model 5 in Tables 3 to 6). Results for within-country quintiles of weekly time spent online are displayed in the second column of Figure 3. In Bulgaria, children in the top two quintiles of time use had significantly lower life satisfaction than children in the bottom quintile. In Chile there was evidence of lower life satisfaction with more time spent online, in line with the results from the models using absolute time use. In Ghana, children in the middle quintile of online time had the highest life satisfaction, and significantly higher than children in the bottom and top quintiles. In the Philippines, children with the lowest amount of time spent online had significantly lower life satisfaction than all other groups, which had roughly comparable levels of life satisfaction. The Philippines had the largest proportion of children using the internet for five hours or less (see

Figure 1). In fact, the first quintile in this country corresponded to an estimated weekly usage of less than 3 hours. The added explanatory power (compared to a model with control variables only) of these models of relative time use was largest in Bulgaria (around 2.7%).

Finally, we conducted Wald tests of whether there was a difference in the association between time spent online and life satisfaction between each pair of countries. Using the 7-hour grouped absolute measure of time use, there were significant differences between Bulgaria and Ghana ($p=0.029$), Bulgaria and the Philippines ($p=0.008$), Chile and Ghana ($p=0.016$), and Chile and the Philippines (0.012). Using a Bonferroni correction to adjust for the number of comparisons being made only the one between Bulgaria and the Philippines differed. Using the relative measure, the same four pairs of countries differed significantly and the p-values were much smaller (all less than 0.001).

The tentative overall conclusion from this analysis is that the association between the time children spend online and life satisfaction differs between two pairs of countries. In Chile and Bulgaria (high- and upper-middle-income countries respectively), there is evidence of a weak association between spending more time online and lower life satisfaction. On the other hand in Ghana and the Philippines (lower-middle-income countries) spending more time online is not linked with lower life satisfaction. This may be linked to the fact that, as discussed earlier, children in Bulgaria and Chile use the internet, on average, much more extensively than in Ghana and the Philippines.

2. Do the associations between children's time spent online and their mental health vary by gender?

To address the second research question, the regression models were run with gender interaction terms using the measures of weekday and weekend use, the 7-hour ordinal measure of absolute time use, and the quintile measure of relative time use. There was no evidence of a significant gender difference in the overall associations between time spent online and life satisfaction in any of the countries using any of these four measures.

3. What is the relative importance of time spent online in influencing children's mental health compared to social or family factors?

The third and final part of the analysis considered the relative importance of time spent online, compared to children's self-reported quality of relationships with family and peers.

First (Model 6), we ran the analysis with quality of family relationships and peer relationships variables plus controls (i.e. without including time spent online in the model). In all four countries, one or both relationship variables made a significant contribution to explaining variations in life satisfaction. Overall these relationship variables had an explanatory power of around 16% in Chile and 9% in Bulgaria. In Ghana and the Philippines their contribution was more modest – between 2% and 3%.

We then ran the analysis also including the relative variable about time spent online (Model 7). In this case we use this variable because our focus is on differences within countries rather than between countries. In Bulgaria, when considered jointly, family relationships, friendships and time spent online all made a significant contribution to explaining variations in life satisfaction. The pattern of relationship between time use and life satisfaction changed little when these relationship variables were taken into account, still showing a significant negative effect. In Chile, very high internet use was significantly associated with lower life satisfaction ($p < 0.05$) once relationships were taken into account. It is clear, however, from a comparison of Models 6 and 7 that family relationships were a much stronger predictor of children's life satisfaction than time spent online. In Ghana and the Philippines both family relationships and time use significantly contributed to the model and the introduction of the relationship variables had relatively little effect on the coefficients for time use. The overall explanatory power of the regression models in these two countries was still modest, with around 3% to 4% added explanatory power compared to the model with only control variables.

Limitations

Before concluding, it is important to reflect on the limitations of this research. While the best possible efforts were made both when designing and administering the survey at the country level, and when analysing and comparing the data, cross-national research is inevitably complicated. A key limitation of the analysis is that it uses cross-sectional data. As a result we cannot make any claims about directions of causality between time spent on the internet and life satisfaction. Although we have focused on the hypothesised effect of internet time on children's life satisfaction, it is equally plausible that lower life satisfaction leads children to spend more time on the internet. It is also possible that the results might be explained by unobserved confounding variables. Longitudinal data would be ideally be needed in future research to explore directions of influence.

Several other limitations should be kept in mind when interpreting the results. First, each national survey was implemented by an individual team of researchers, often using its own resources which in some cases were limited. The four countries differed in terms of each national team's capacity and approach to conducting representative household surveys with children, resulting in some differences in the random sampling methods used. Sample quality thus varies, affecting the strict comparability of findings. The most marginalized or vulnerable children were likely not included in the sample, as they may not live in households but on the street or in institutions. Moreover, as noted earlier, there were substantial amounts of missing data for several variables in the Philippines, and for the relationship variables in Chile. The results presented for the Philippines and for the third research question in Chile should not therefore be viewed as necessarily representative of the total population of children using the internet in those countries. Second, the questionnaire was administered in the child's home. While every effort was made to ensure privacy, reassuring children that no one would read their answers, it is both possible and understandable that children may have given socially desirable answers, especially

as a parent was sometimes present. Third, it can be difficult for children to estimate the amount of time they spend online. This introduces some uncertainty into our main predictor, which can only be overcome by objective measures. Fourth, we only have a single-item measure of one aspect of mental health, namely life satisfaction. As identified in previous research discussed in the introduction, patterns of internet use may be differentially related to different aspects of mental health. Further research is needed with a more comprehensive set of indicators of mental health and, more broadly, of children's well-being.

Discussion and conclusions

This paper used comparable data on children's internet use from four countries in different regions of the world. The purpose was to understand more about whether and how the time children spend online impacts their mental health, and whether it is relevant in comparison to other factors known to affect their well-being.

We observe different patterns across these four contrasting countries, though some similarities as well. Possibly, these differences can be explained either by socio-economic status or by considering where these countries are in their internet adoption trajectory. Or, factors not included here might be more important for children's mental health in some countries than others.

The extent of internet usage by children varies across the four countries. Children in Chile use the internet for around 20 hours per week or more, on average. The average is around 15 hours per week in Bulgaria and around 11 to 12 in both Ghana and the Philippines. Bearing in mind that these are samples of children who have access to and use the internet, these differences are not explained directly by rates of access. There could be a number of explanations including cost, type and quality of access, or choices made by parents or by children themselves.

Turning to the connection between time spent online and life satisfaction, we find differences in patterns depending on whether one takes a relative or absolute perspective on time use. A relative perspective classifies children into groupings of higher or lower usage compared to other children in the same country. An absolute perspective is based on the amount of time spent irrespective of the pattern within the country. Both approaches have their merits. The absolute approach offers direct comparisons across countries of the effect of a given quantity of internet usage. On the other hand it decontextualises patterns of internet usage. The relative approach locates children's internet usage within a continuum in their own country.

In Bulgaria and Chile, upper-middle and high-income countries respectively, where a majority of children are connected, we observe quite similar patterns. Our analysis shows that, whether one considers relative or absolute measures, higher-frequency internet use is associated with only a small reduction in life satisfaction. These patterns are in line with what might be expected by looking at previous research conducted in high-income countries.

In Ghana, a low-to-middle income country where internet access for children is still relatively recent, we observe a somewhat different profile. There is no association between an absolute measure of hours of internet access per week and life satisfaction. However this pattern is imprecisely estimated because relatively few children use the internet extensively. The association between time spent online relative to other children in Ghana and life satisfaction resembles the inverted U-shaped relationship previously observed in some research in high-income countries (Przybylski & Weinstein, 2017). This suggests that for children in Ghana there is an optimal amount of use, somewhere between no use and heavy use. The strength of this relationship is modest, also consistent with previous research, but was found to be significantly different to the patterns in other countries.

In the Philippines, there is a distinctive profile not seen in previous research. Using an absolute measure the picture is similar to Ghana with no evidence of link between hours of internet use and life satisfaction. However, using a relative measure it is children with low-frequency time spent online who have significantly lower life satisfaction than other children; while there is no difference in life satisfaction at higher levels of use. Considering that we controlled for socio-economic differences in our analysis, this finding suggests a deprivation model where those without access at all might fall behind. The lower life satisfaction might be due to children without access missing out on important social connections and experiences, being unable to participate in the same activities as their peers. However, as with Ghana the explanatory power of time spent online is small and its importance should not be overstated.

The above patterns refer to total weekly use. Some previous research (e.g. Przybylski & Weinstein, 2017) has identified different patterns in the relationship between, respectively, weekday and weekend use and children's mental well-being. In these four countries, we only found evidence for such differences in Chile where there was some evidence of an inverted U-shaped relationship, at the weekend only, whereby children with moderate internet use had the highest life satisfaction.

We also explored the hypothesis that there may be gender differences in the association between extent of internet use and life satisfaction. Some previous research (e.g. McDool et al., 2016) has found stronger associations for girls than boys. We did not find any evidence to support this hypothesis in any of the four countries.

Taken together, these patterns represent an important step forward in understanding the relationship between children's internet use and mental health globally. Mainly, it reveals that patterns observed in one country cannot be assumed to apply universally, yet findings from Europe or United States are often extrapolated to other contexts to drive policy and practitioner discourses around children's engagement with the internet. There are likely to be a number of contextual factors in each country that explain the underlying relationship between time spent online and mental health, and that these factors in turn attenuate or accentuate this relationship. This calls for more national-level research on children's internet use globally, to identify which

factors matters for children's mental health as well as understanding the particular role of technology in mediating these relationships.

A point of similarity across the four countries that supports other recent research is that the link between time spent online and life satisfaction is generally weak and may not be substantively important unless it reaches extreme levels of deprivation or overuse. We explored the relative explanatory power of internet use compared to self-reported measures of children's quality of relationships with family and friends. Findings in Chile and the Philippines are tentative owing to levels of missing data for the questions about relationships, meaning that the resulting samples may not be entirely representative. However, there was a similar pattern across all four countries. The measures of quality of relationships explained much more of the variation in life satisfaction than did time spent online. This is not surprising given other research findings about the central importance of relationships for children's sense of well-being (e.g. Huebner, Antaramian & Heffner, 2012).

Indeed, scholars are increasingly of the view that we should look beyond screen time measures and instead consider what other factors more substantially influence children's mental health (Stiglic and Viner, 2019, Przybylski & Weinstein, 2017). Arguments have been made that the specific content, contacts and conduct children encounter online might be more relevant when trying to understand how internet use affects them (Livingstone, Haddon & Görzig, 2012). However, analysing the effects of content, contact and conduct online is complicated by the fact that few datasets include such indicators in any reliable or comprehensive way. The few datasets that contain such indicators tend to be highly focused on the online environment, lacking appropriate indicators for other factors that are important to child mental health or well-being, such as children's socio-economic situation, their family relationships or peer support networks.

The findings presented here suggest that improving the quality of family and peer relationships should take precedence over restricting the time children spend online, but also that more substantive research on children's mental health in relation to their internet use would be beneficial. We recommend that those designing future surveys should develop more nuanced measures of internet use that go beyond counting time spent online and recognise the likely relevance of particular kinds of digital content, contact and conduct. In the meantime, insofar as policy makers, practitioners and parents wish to support children's mental health and well-being, there are likely to be many other more relevant points of intervention than focusing on time spent on the internet.

Key points and relevance

- Children's internet use is rapidly growing globally.
- Evidence on the link between frequency of internet use and children's mental health is mixed and is primarily from high-income countries.
- We found that higher-frequency internet use was only weakly associated with lower mental health in two countries (Bulgaria and Chile) and that this pattern did not hold in two others (Ghana and the Philippines). The quality of children's relationships was much more strongly related to their mental health.
- Improving children's relationships has greater potential to improve their mental health than limiting their internet use.
- Future research should consider expanding the range of countries covered; avoid generalising across countries; and explore the nature, rather than quantity, of children's internet use.

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Table 1: Country sample details

	Sample size	Age group	Language	Fieldwork	Institution(s)
Bulgaria	1,000 children 1,000 parents	9 – 17	Bulgarian	2016	ARC Fund / Bulgarian Safer Internet Centre
Chile	1,000 children 1,000 parents	9 – 17	Spanish	2016	Pontificia Universidad Católica de Valparaíso
Ghana	2,060 children 1,000 parents	9 – 17	Twi, Ewe, Dagbani, Hausa	2017	UNICEF Ghana
Philippines	1,873 children 1,873 parents	9–17	Tagalog	2018	UNICEF Philippines

Table 2: Descriptive statistics

		Bulgaria	Chile	Ghana	Philippines
<i>Well-being</i>					
Life satisfaction	Mean (SD)	8.47 (1.68)	8.25 (1.84)	7.57 (2.05)	6.86 (2.67)
	Skewness/Kurtosis	-1.15 / 4.02	-1.16 / 4.25	-0.88 / 3.79	-0.70 / 2.88
<i>Internet use</i>					
Weekly hours	Mean (SD)	15.59 (10.55)	20.07 (14.5)	11.46 (10.37)	11.68 (12.35)
<i>Relationships (range from 0 to 3)</i>					
Family talk	Mean (SD)	2.42 (0.76)	2.24 (0.99)	0.97 (0.90)	1.83 (0.85)
Family listen	Mean (SD)	2.50 (0.81)	1.88 (0.99)	2.23 (0.79)	1.54 (0.80)
Family help	Mean (SD)	2.72 (0.64)	2.18 (0.91)	2.60 (0.60)	1.95 (0.76)
Friends help	Mean (SD)	1.96 (0.90)	1.60 (1.01)	2.35 (0.74)	1.48 (0.87)
Friends rely on	Mean (SD)	2.17 (0.81)	1.48 (1.03)	2.44 (0.68)	1.42 (0.88)
Friends talk	Mean (SD)	2.12 (0.84)	1.68 (1.07)	2.31 (0.81)	1.38 (0.91)
<i>Controls</i>					
Age	Mean (SD)	12.72 (2.67)	13.66 (2.41)	12.89 (2.65)	13.16 (2.44)
Gender	% female	48.90%	50.40%	48.20%	54.50%
SES=1	%	11.30%	34.30%	72.10%	53.60%
SES=2	%	14.70%	47.80%	27.90%	33.50%
SES=3	%	20.40%	17.90%		2.30%
SES=4	%	17.50%			
SES=5	%	22.90%			
SES=6	%	13.20%			
SES=Missing	%				10.60%

Table 3: Regressions of children's life satisfaction onto online activities and relationships, Bulgaria

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<i>Weekday/Weekend use (None=Ref)</i>							
30 mins.	-0.075	-0.531					
1 hour	-0.034	-0.572					
2 hours	-0.479*	-0.267					
3 hours	-0.46	-0.379					
4 hours	-0.456	-0.867*					
5 hours	-0.673	-1.057*					
6 hours	-0.668	-0.959*					
7+ hours	-1.317**	-0.816					
<i>Estimated weekly use</i>							
Hours			-0.0235**				
<i>7-hour groupings of weekly use (0 to 6.5 hours = Ref)</i>							
7 to 13.5 hrs				0.009			
14 to 20.5 hrs				-0.418*			
21 to 27.5 hrs				-0.522**			
28 to 34.5 hrs				-0.419			
35 to 41.5 hrs				-0.354			
42 to 48.5 hrs				-0.819			
49 to 55.5 hrs				-1.527**			
<i>Relative within-country weekly use (Lowest 20% = Ref)</i>							
2nd lowest 20%					0.215		0.194
Middle 20%					-0.165		-0.139
2nd highest 20%					-0.487**		-0.476**
Highest 20%					-0.568**		-0.465**
<i>Relationships with family and friends</i>							
Family talk						0.517**	0.491**
Family listen						-0.079	-0.052
Family help						0.119	0.089
Friends help						0.286**	0.260**
Friends rely on						0.243*	0.251*
Friends talk						-0.226*	-0.201*
Constant	9.428**	9.794**	9.452**	9.368**	9.219**	7.235**	7.071**
Observations	972	972	972	972	972	956	956
R-squared	7.9%	8.4%	7.5%	8.1%	8.4%	15.1%	17.2%
Added R-squared	+2.2%	+2.7%	+1.8%	+2.4%	+2.7%	+9.4%	+11.5%

Notes: Each column shows the results of a linear regression which also includes age, gender and family socio-economic status as control variables. Asterisks indicate p-values <0.05 (*) and <0.01(**) respectively. The added R-squared row indicates the additional explanatory power of each model compared to a model only containing the control variables.

Table 4: Regressions of children’s life satisfaction onto online activities and relationships, Chile

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<i>Weekday/Weekend use (None=Ref)</i>							
30 mins.	0.037	0.555					
1 hour	-0.093	0.929**					
2 hours	-0.071	0.508					
3 hours	-0.471*	0.216					
4 hours	-0.397	0.046					
5 hours	-0.223	0.196					
6 hours	-0.819*	0.086					
7+ hours	-0.600*	-0.101					
<i>Estimated weekly use</i>							
Hours			-0.017**				
<i>7-hour groupings of weekly use (0 to 6.5 hours=Ref)</i>							
7 to 13.5 hrs				-0.303			
14 to 20.5 hrs				-0.117			
21 to 27.5 hrs				-0.547**			
28 to 34.5 hrs				-0.516*			
35 to 41.5 hrs				-0.460*			
42 to 48.5 hrs				-0.890**			
49 to 55.5 hrs				-0.851**			
<i>Relative within-country weekly use (Lowest 20%=Ref)</i>							
2nd lowest 20%					-0.282		-0.154
Middle 20%					-0.146		0.003
2nd highest 20%					-0.542**		-0.296
Highest 20%					-0.667**		-0.471*
<i>Relationships with family and friends</i>							
Family talk						-0.409**	-0.408**
Family listen						0.205*	0.196*
Family help						0.648**	0.653**
Friends help						0.178	0.181
Friends rely on						0.080	0.082
Friends talk						-0.039	-0.010
Constant	9.928**	9.478**	9.946**	9.962**	9.968**	7.644**	7.474**
Observations	978	978	978	978	978	749	749
R-squared	5.7%	7.0%	5.7%	6.1%	5.7%	20.0%	20.8%
Added R-squared	+1.4%	+2.7%	+1.4%	+1.8%	+1.4%	+15.7%	+16.5%

Notes: Each column shows the results of a linear regression which also includes age, gender and family socio-economic status as control variables. Asterisks indicate p-values <0.05 (*) and <0.01(**) respectively. The added R-squared row indicates the additional explanatory power of each model compared to a model only containing the control variables.

Table 5: Regressions of children’s life satisfaction onto online activities and relationships, Ghana

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<i>Weekday/Weekend use (None=Ref)</i>							
30 mins.	0.219	-0.115					
1 hour	0.363*	0.19					
2 hours	0.147	0.403*					
3 hours	-0.0191	0.114					
4 hours	0.0995	0.207					
5 hours	-0.774	0.006					
6 hours	-0.524	-0.111					
7+ hours	-0.151	-0.165					
<i>Estimated weekly use</i>							
Hours							-0.009*
<i>7-hour groupings of weekly use (0 to 6.5 hours=Ref)</i>							
7 to 13.5 hrs				0.236*			
14 to 20.5 hrs				-0.12			
21 to 27.5 hrs				-0.082			
28 to 34.5 hrs				-0.121			
35 to 41.5 hrs				-0.514			
42 to 48.5 hrs				-0.518			
49 to 55.5 hrs				-0.486			
<i>Relative within-country weekly use (Lowest 20%=Ref)</i>							
2nd lowest 20%					0.385**		0.410**
Middle 20%					0.657**		0.603**
2nd highest 20%					0.314*		0.327*
Highest 20%					0.059		0.140
<i>Relationships with family and friends</i>							
Family talk						0.194**	0.190**
Family listen						0.143*	0.142*
Family help						0.069	0.061
Friends help						0.030	0.028
Friends rely on						0.016	0.016
Friends talk						-0.014	-0.018
Constant	6.489**	6.707**	6.715**	6.635**	6.553**	5.784**	5.626**
Observations	2,059	2,059	2,059	2,059	2,059	2,059	2,059
R-squared	1.7%	1.6%	1.1%	1.6%	1.9%	3.1%	3.9%
Added R-squared	+0.8%	+0.7%	+0.2%	+0.7%	+1.0%	+2.2%	+3.0%

Notes: Each column shows the results of a linear regression which also includes age, gender and family socio-economic status as control variables. Asterisks indicate p-values <0.05 (*) and <0.01(*) respectively. The added R-squared row indicates the additional explanatory power of each model compared to a model only containing the control variables.

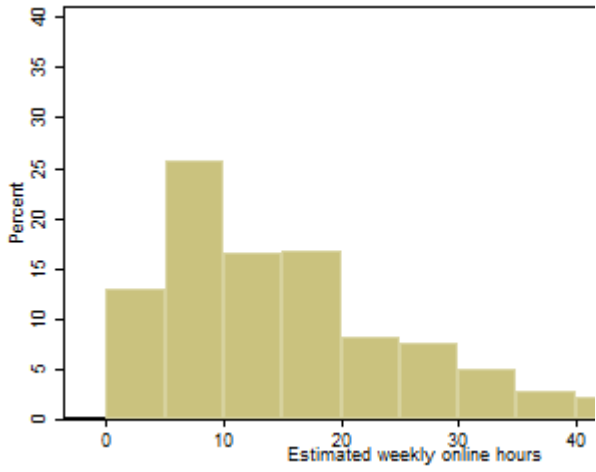
Table 6: Regressions of children's life satisfaction onto online activities and relationships, Philippines

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<i>Weekday/Weekend use (None=Ref)</i>							
30 mins.	0.354	0.444					
1 hour	0.443*	0.536*					
2 hours	0.610*	0.725**					
3 hours	0.603*	0.486					
4 hours	0.401	0.206					
5 hours	0.705	0.663*					
6 hours	0.235	0.397					
7+ hours	0.353	0.217					
<i>Estimated weekly use</i>							
Hours			0.0058				
<i>7-hour groupings of weekly use (0 to 6.5 hours=Ref)</i>							
7 to 13.5 hrs				0.205			
14 to 20.5 hrs				0.234			
21 to 27.5 hrs				0.300			
28 to 34.5 hrs				0.308			
35 to 41.5 hrs				0.231			
42 to 48.5 hrs				0.337			
49 to 55.5 hrs				0.018			
<i>Relative within-country weekly use (Lowest 20%=Ref)</i>							
2nd lowest 20%					0.567**		0.472*
Middle 20%					0.536*		0.595**
2nd highest 20%					0.470*		0.515*
Highest 20%					0.528*		0.568*
<i>Relationships with family and friends</i>							
Family talk						0.295**	0.278**
Family listen						0.306**	0.290**
Family help						0.202	0.221*
Friends help						0.151	0.137
Friends rely on						-0.034	-0.042
Friends talk						-0.219*	-0.220*
Constant	7.081**	6.806**	7.298**	7.274**	6.969**	6.128**	5.914**
Observations	1,498	1,498	1,498	1,498	1,498	1,243	1,243
R-squared	3.0%	3.1%	2.5%	2.6%	3.0%	5.1%	5.8%
Added R-squared	+0.6%	+0.7%	+0.1%	+0.2%	+0.6%	+2.7%	+3.4%

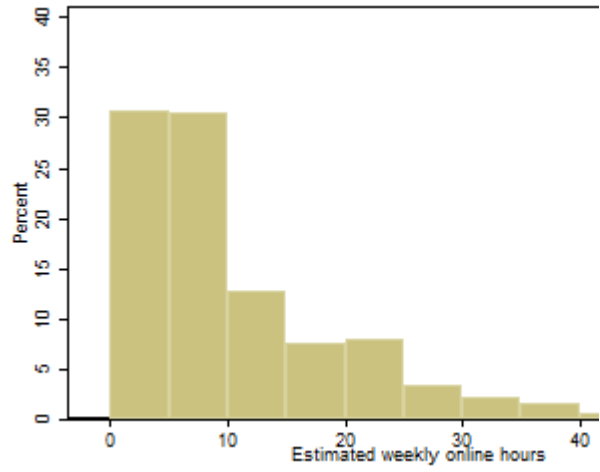
Notes: Each column shows the results of a linear regression which also includes age, gender and family socio-economic status as control variables. Asterisks indicate p-values <0.05 (*) and <0.01(**) respectively. The added R-squared row indicates the additional explanatory power of each model compared to a model only containing the control variables.

Figure 1: Histograms of distribution of estimated weekly online hours

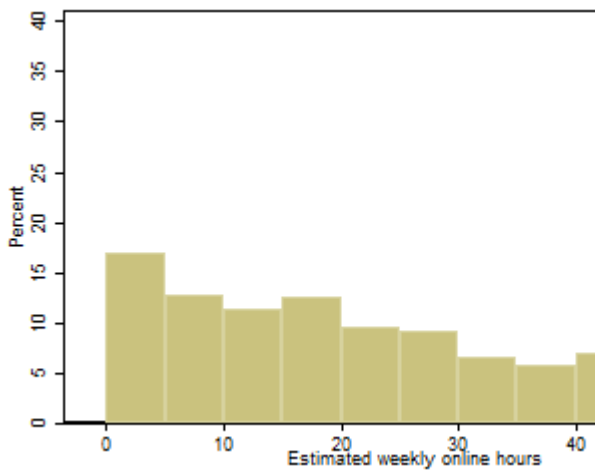
Bulgaria



Ghana



Chile



Philippines

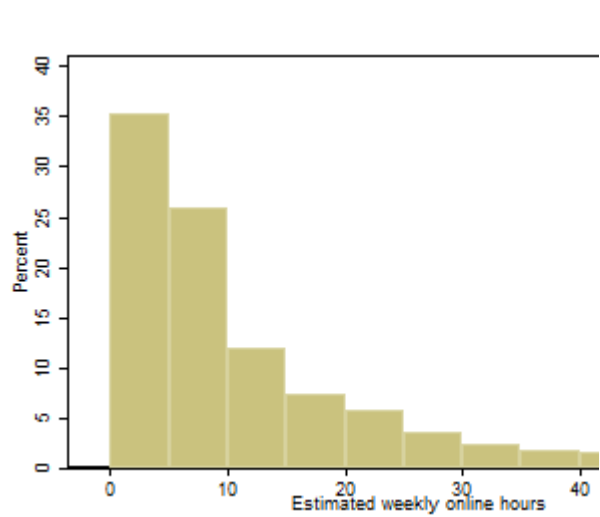
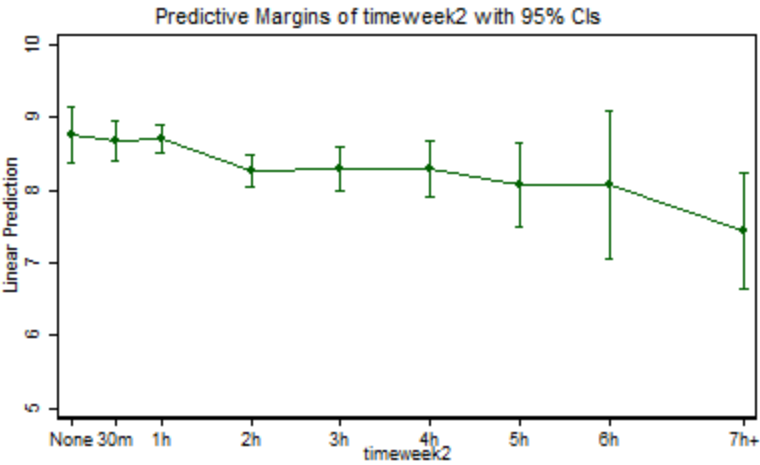
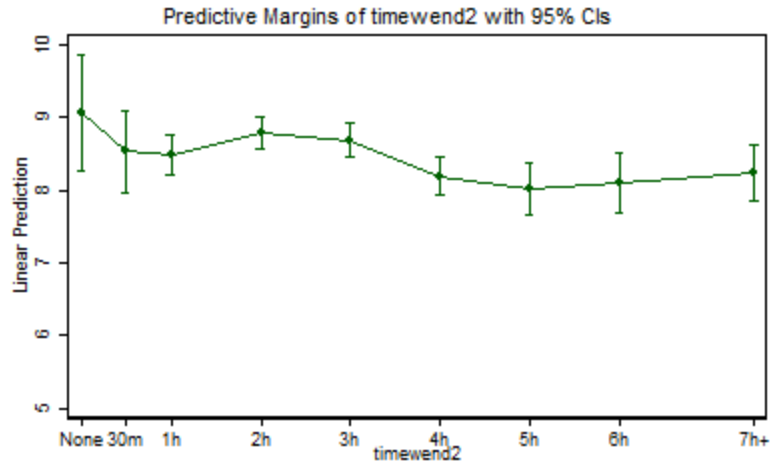


Figure 2: The associations of weekday and weekend online use with life satisfaction

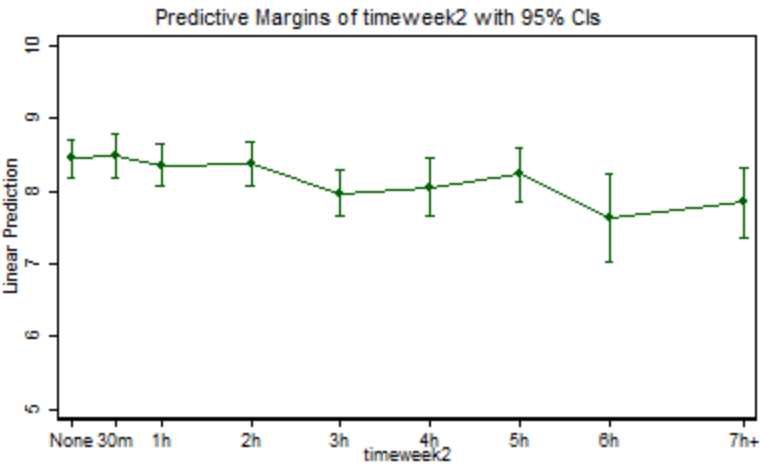
Bulgaria
Weekday



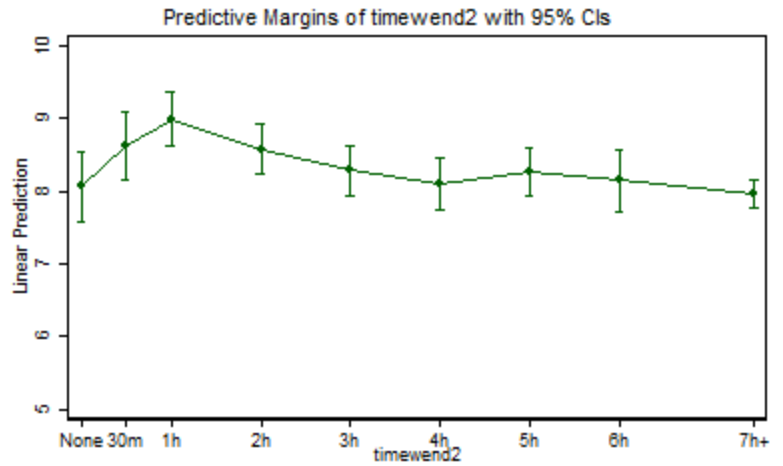
Weekend



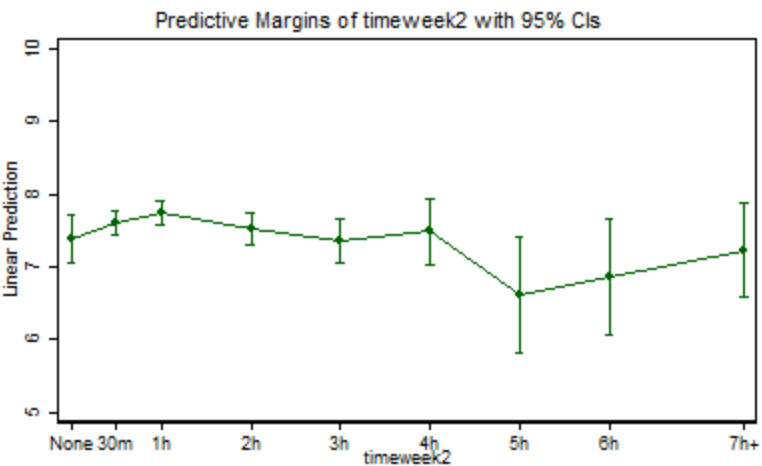
India
Weekday



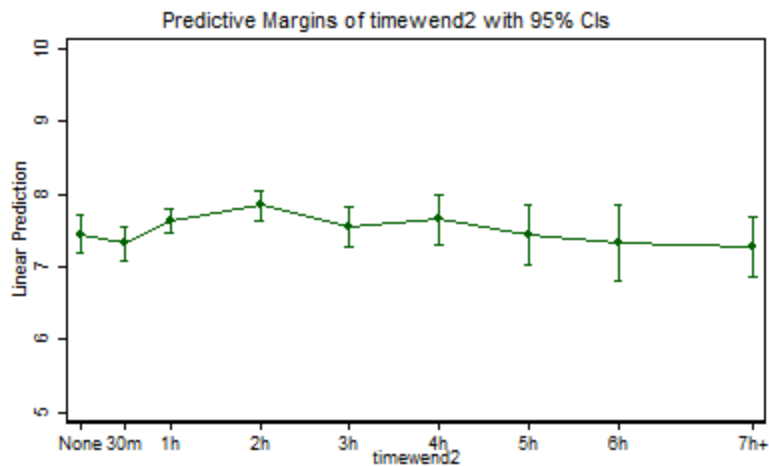
Weekend



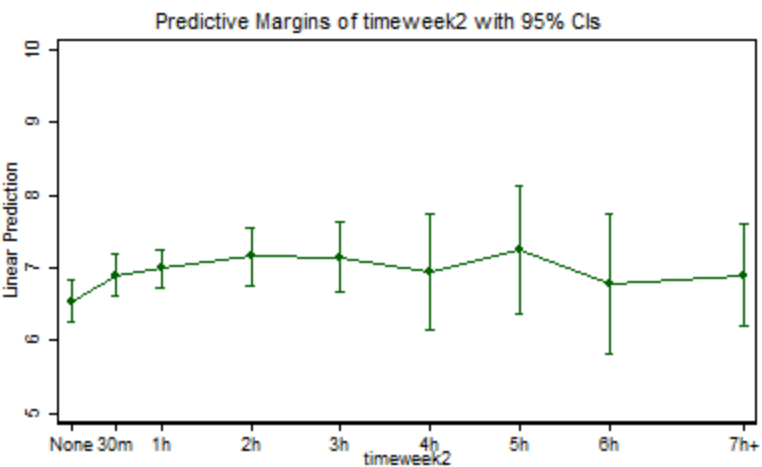
hana
Weekday



Weekend



hilippines
Weekday



Weekend

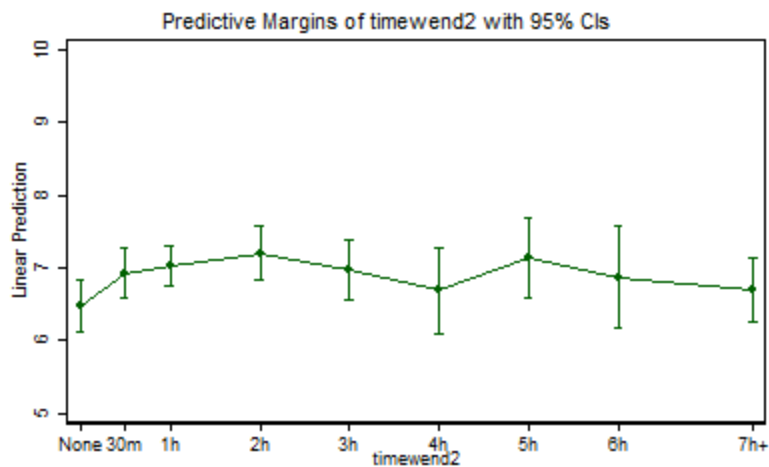
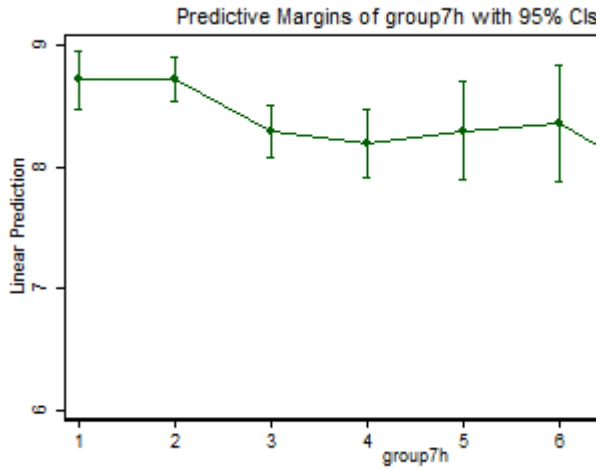


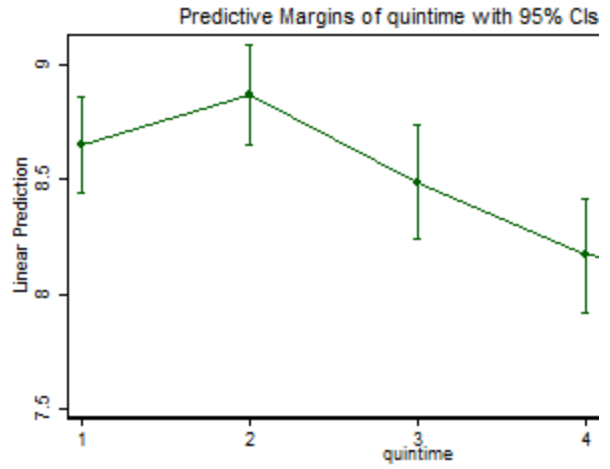
Figure 3: The associations between absolute and relative weekly online use and life satisfaction

Bulgaria

Absolute

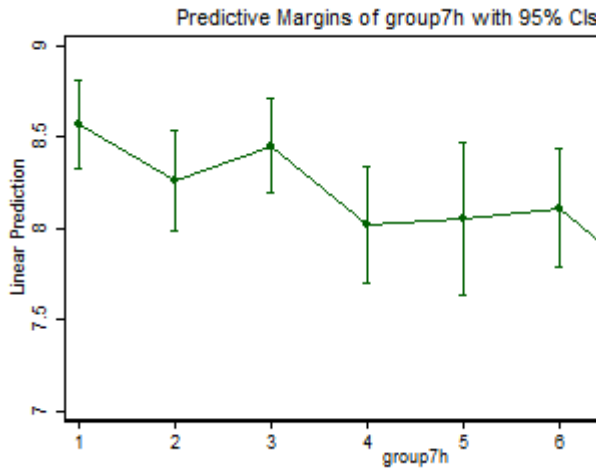


Relative

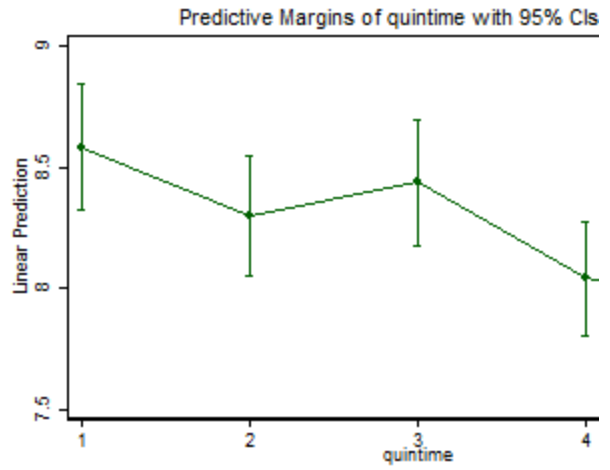


Chile

Absolute

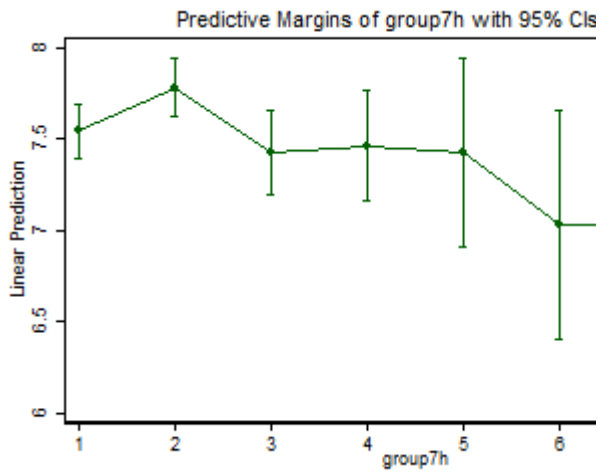


Relative

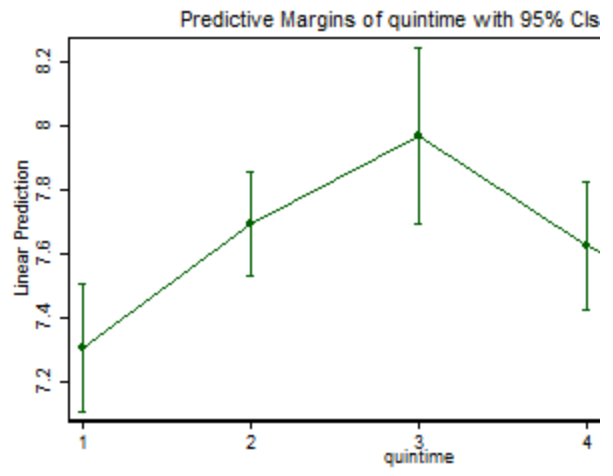


Ghana

Absolute

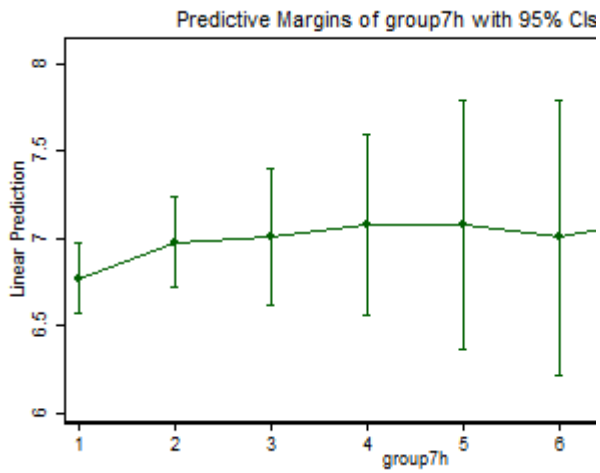


Relative



Philippines

Absolute



Relative

