Representativeness of the Global Mind Project Data for the United States: A Comparison with National Statistics

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Background

The growth of internet and mobile phone usage has opened up opportunities for new sampling and recruitment paradigms that reach global populations at a faster rate and lower cost. The Global Mind Project (GMP) uses an internet-based recruitment strategy that dynamically targets respondents by age, sex and geography. However, the representativeness of this approach is not yet known.

Objective

To determine the representativeness of GMP data by comparing demographic and social trends acquired by the GMP and time-matched trends from the American Community Survey (ACS) and Household Pulse Survey (HPS) conducted by the United States Census Bureau and the American Trends Panel (ATP) conducted by Pew Research.

Methods

Data were taken from the GMP database where recruitment was conducted via campaigns on Facebook and Google AdSense that dynamically targeted age-sex and geographic groups using a broad range of interest keywords. Respondents residing in the United States who completed the English language version of the GMP survey were included in the study (n=70,800). GMP data were compared against time-matched data from the ACS, HPS and ATP for questions where there were exact or near-exact matches. These included educational attainment, marital status, percentage seeking mental health treatment and number of close friends.

Results

For educational attainment, the percentage of High school or higher in GMP was closely aligned with ACS for all but the 18-24 age group (average difference ±1.4%, 11.8% higher percentage of high school graduates in GMP 18-24 group). For marital status, the GMP data showed a higher proportion (5.7%) of never married respondents across all ages except 18-24. For the percentage seeking mental health treatment, estimates from the GMP were within ±0.9% of national estimates from the HPS for 3 out of 4 years. Across age groups, there was

42   a 5-8% average difference in the proportion seeking treatment between GMP and HPS.

43   Finally, GMP respondents were more likely to report only 2 close friends or less (15.3%

44   difference vs ATP) with 10.3% less likely to report 5+ friends.

45

46   Conclusions

47   Data trends in the GMP showed generally good alignment with those obtained through more

48   rigorous sampling techniques, with a slight bias in GMP data towards single people with fewer

49   friends who were seeking mental health treatment. Altogether, we have shown the potential of

50   a dynamically stratifying sampling approach in providing a rapidly scalable real-time view of

51   mental wellbeing as well as demographic and social trends.

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54   Key words:

55   Population health; mental health; survey; methods; global mind project; MHQ;

56   representativeness

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Introduction

Over the past few decades, the growth of the internet and mobile phone usage across the world [1] has provided an opportunity for new online sampling and recruitment paradigms in the context of public and preventative health research that can reach a large-scale and broad cross-section of the global population at a much faster rate and lower cost.

The Global Mind Project (GMP) is a unique effort which uses global online population sampling with the goal of providing a real time view of evolving mental wellbeing and the social, technological and lifestyle factors that drive it. It surveys various demographic, cultural, lifestyle, and life experience factors, including age, sex, ethnicity, education, employment status, and income, as well as 47 aspects of mental health and wellbeing on a 9-point scale. It operates in 14 languages across 71 countries and has obtained data from 1.3 million people since its launch in 2020. Individuals are anonymously recruited using paid advertisements placed on internet and social media channels including Google Ads, and Facebook inviting them to complete an anonymous 15-minute online assessment. The assessment provides individuals a free personalized report that synthesizes across their responses to provide mental wellbeing scores and self-help guidance. In addition, it uses a dynamically adjustable quota-based recruitment strategy which systematically targets pre-defined age-sex groups across a series of selected geographies using a broad range of interest criteria/keywords with the goal of robust representation of the general population in each age-sex band for different countries of interest. In addition, since it is not possible to pre-emptively ensure exact proportionate representation of these age and sex groups through an open online survey, the approach also uses post-stratification weighting to match age-sex proportions in the sample to national population statistics [2,3].

However, there is considerable debate in the literature around the representativeness of data generated through online recruitment methods (e.g. via advertisements on Facebook) [2,4–18]. Furthermore, when online surveys are conducted anonymously, it leads to concerns about fraudulent, misrepresentative or bot responses within the sample [19,20]. The objective of this study was therefore to determine the representativeness of the GMP data from the United States by comparing it against equivalent, time-aligned data taken from 3 well established surveys of the US population: the American Community Survey (ACS) from the US Census Bureau [21], the Household Pulse Survey (HPS) from the US Census Bureau [22], and the American Trends Panel (ATP) conducted by the Pew Research Foundation [23]. Specifically, educational attainment and marital status trends by age and biological sex were compared, as well as the percentage seeking treatment for mental health problems, and number of close friends.

Methods

GMP Recruitment

Data for this study were taken from the GMP database. Recruitment was conducted via campaigns on Facebook and Google AdSense with advertisements containing the copy 'Get your mental wellbeing score: Fast, Free, Anonymous' along with a button linking to the start

of the open survey [24]. The advertisements were regionally targeted towards a series of age-sex groups between 18 and 85 years using a broad range of interest keywords that had been optimized to ensure sufficient quotas in each age-sex group and broad geographic region. In addition, advertisements were continually and dynamically managed in response to feedback on the demographic composition of respondents to further ensure sufficient representation across age and biological sex groups. Starts and completions were tracked for each advertisement within each source (Google and Facebook) using Google and Facebook Analytics and data from all new sources were analyzed for parity before a new advertisement or source was scaled and included.

GMP Data Processing

For the purpose of this study, only data from respondents who completed the English language version of the GMP survey between April 1st 2020 and December 1st 2023 and who selected United States (US) in response to the question "Which country do you live in?" were included (see discussion for future plans with other countries). Respondents who completed the assessment in under 7 minutes (the minimum time needed to read all questions), took more than 60 minutes to complete the assessment, found the assessment difficult to understand (answered "No" to the question: Did you find this assessment easy to understand?), or had responses with a standard deviation of less than 0.2 (representing people who answered with the same value across all 47 rating items) were excluded from the analysis. Completions arising from organic traffic including peer referrals were excluded as they lay outside the managed targeting criteria. This resulted in 14% being excluded from the analysis. After cleaning, the data sample size was 12,255 in 2020, 20,422 in 2021, 22,396 in 2022 and 15,727 in 2023.

Comparison against the ACS, HPS and ATP Data

The ACS, conducted by the US Census Bureau, samples 3.5 million people each year by sending a physical mailing to selected households requesting them to respond via the internet or by returning a completed questionnaire via mail [21]. Those who do not respond are followed up with a personal visit and potentially risk a fine for non-participation. As a result, the ACS typically achieves a 85% participation rate, post the Covid-19 pandemic [25]. The HPS, which is also conducted by the US Census Bureau in collaboration with multiple federal agencies including the Centers for Disease Control and Prevention (CDC) and aims to be more cost efficient and timely, sends invitations to participate by email or text message with a link to complete the survey online [22]. Unlike the ACS, however, it does not follow up nonresponses with a personal visit and therefore has a higher nonresponse rate. Pew's flagship American Trends Panel (ATP; [23]) takes a similar approach to the ACS albeit on a smaller scale where a panel is recruited through national, random sampling of residential addresses selected from the US Postal Service's Delivery Sequence File and asked to complete surveys online.

GMP US survey data was compared against data from the ACS, HPS and ATP. As the GMP collects data on a wide variety of demographics, cultural, lifestyle and life experience factors,

only questions where there was an exact or near-exact match to questions in the ACS, HPS and ATP were selected for inclusion in this study to ensure an accurate comparison. This included educational attainment and marital status by age and biological sex from GMP and ACS obtained in 2022, the percentage seeking treatment for mental health problems from GMP and HPS from 2020 to 2023 and number of close friends from GMP and ATP for 2023.

For each of these data elements within the GMP, the percentage of respondents selecting each answer option were computed for each age and biological sex group. In all cases, this was done by first computing averages for each age-sex group and then computing a weighted average based on the proportion of the population in each age group as provided by the United Nations (UN) Population Statistics [26]. For each of the comparison surveys (ACS, HPS, ATP), precalculated numbers by age and biological sex or national aggregates were directly downloaded from the respective survey sites.

Comparison of marital and education status data in the GMP and ACS

ACS 2022 data was downloaded from the ACS data website [27]. The specific ACS tables downloaded were S1501 (Educational Attainment; n=~3 million) and B12002 (Marital Status; n=~3 million). ACS Table S1501 reports education attainment as percentage with High School or Higher and percentage with Bachelor's or Higher. To create a comparable metric from the equivalent 2022 GMP data (n=25,124), the percentage with Bachelor's degree, Master's Degree and PhD degree were summed as percentage Bachelor's or higher, while percentage with High School and Associate degree were added to this to arrive at percentage High School or Higher.

ACS marital status options provided were Never Married, Married/Spouse Present, Married/Separated, Married, Spouse absent, Divorced, Widowed while GMP marital status options provided were: Single (Never Married), In a relationship, Married/Civil Partnership, Divorced/Separated, Widowed, Prefer not to say (n=25,124). Given the slight differences, the data were aggregated and compared as follows: (i) ACS Never Married to GMP Single (Never Married) + In a relationship; (ii) ACS Divorced + Married but Separated to GMP Divorced/Separated; (iii)ACS Married/Spouse present to GMP Married/Civil Partnership; (iv) ACS Widowed to GMP Widowed.

Comparison of mental health treatment status in GMP and HPS

The percentage seeking treatment for mental health problems captured as part of the HPS from January 2020 to October 2023 (N=2,036,992) was compared to the equivalent information captured by the GMP across the same time period (N=87,583). The HPS asked the following questions:

HPS1: At any time in the last 4 weeks, did you take prescription medication to help you with any emotions or with your concentration, behavior, or mental health? Yes/No

187 HPS2: At any time in the last 4 weeks, did you receive counseling or therapy from a mental
188 health professional such as a psychiatrist, psychologist, psychiatric nurse, or clinical social
189 worker? Include counseling or therapy online or by phone. Yes/No

190 While the GMP asked:

191 GMP1: Are you presently undergoing treatment for any mental health challenges? Yes/No

192 Specifically, the percentage of those who answered "Yes" to GMP1 above was compared to
193 the percentage who answered "Yes" to either HPS1 or HPS2. Age-sex weighted national
194 estimates from 2020 to 2023 were also compared, as well as the age-wise break-up for 2023
195 alone. Calculated results for those who answered "Yes" to either HPS1 or HPS2 by age and
196 year were downloaded directly from the CDC site [28]. Annual estimates were arrived at by
197 averaging results across multiple time periods of the HPS survey reported during the same year.
198 The HPS reported aggregated data by age bands 18-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80
199 years and above, while the GMP captured age data in bands 18-24, 25-34, 35-44, 45-54, 55-
200 64, 65-74, 75-84. 85+. Since only pre-aggregated results were available for the HPS this did
201 not afford a perfectly age-aligned comparison.

Comparison of number of close friends in GMP and ATP
203 The average percentage of the population with each number of close friends from 0 to 5+ in
204 the ATP, obtained during July 2023 (N=5,057) was compared against the equivalent GMP data
205 obtained between January 1st and November 30th 2023 (N=19,857). The results from the ATP
206 used responses to the question: 'Not counting your family, how many close friends do you
207 have?' with answer options 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more. The average percentages of
208 the population reporting each number of close friends in the ATP were weighted to be
209 representative of the US adult population by sex, race, ethnicity, education, and other
210 categories. Equivalent percentages were computed from the GMP data for the similar question:
211 "How many close friends do you have?" with a numerical response field. These were age-sex
212 weighted using national statistics from UN to reflect their proportions in the population.
213

Results
Demographic Trends in the ACS were mirrored in the GMP data
216 Figure 1 shows a comparison of educational attainment and marital status by age group for data
217 obtained by ACS (N=~3.5M) and the GMP (GMP; N=25,117) in 2022. Overall, trends for both
218 educational attainment (Figure 1A) and marital status (Figure 1B) in the GMP data closely
219 matched trends in the ACS data. However, a few differences were noted. For educational
220 attainment, the propotion of High school or higher was 11.8% higher in the GMP than ACS in
221 the 18-24 age group. For other age groups the difference ranged from ±0.1% to ±2.7% (average
222 ±1.4%). The GMP age question captures 18-24 as a group, therefore it is possible that this
223 group either contained a smaller proportion of 18-year-olds, the majority of whom are still in
224 high school, or that 18-year old's close to completing high school choose "High School" for
225 educational attainment in preference over "Some High School" which was the alternative
226 option available. Presently, those still in high school are directed to a youth MHQ survey. For

marital status, the GMP data showed a higher proportion of never married respondents across all ages except 18-24 (average difference 5.7%; range ±1.1% to ±8.7%) and a correspondingly lower proportion of married respondents (average difference 7.1% difference; range ±1.0% to ±10.2%). For 18-24 year olds, there was a higher proportion of never married respondents in ACS data (7.2%), while the proportion married was similar (1.0% difference). 2.5% chose "Prefer not to say" in the GMP and were not included which may explain some of the difference between married and never married.
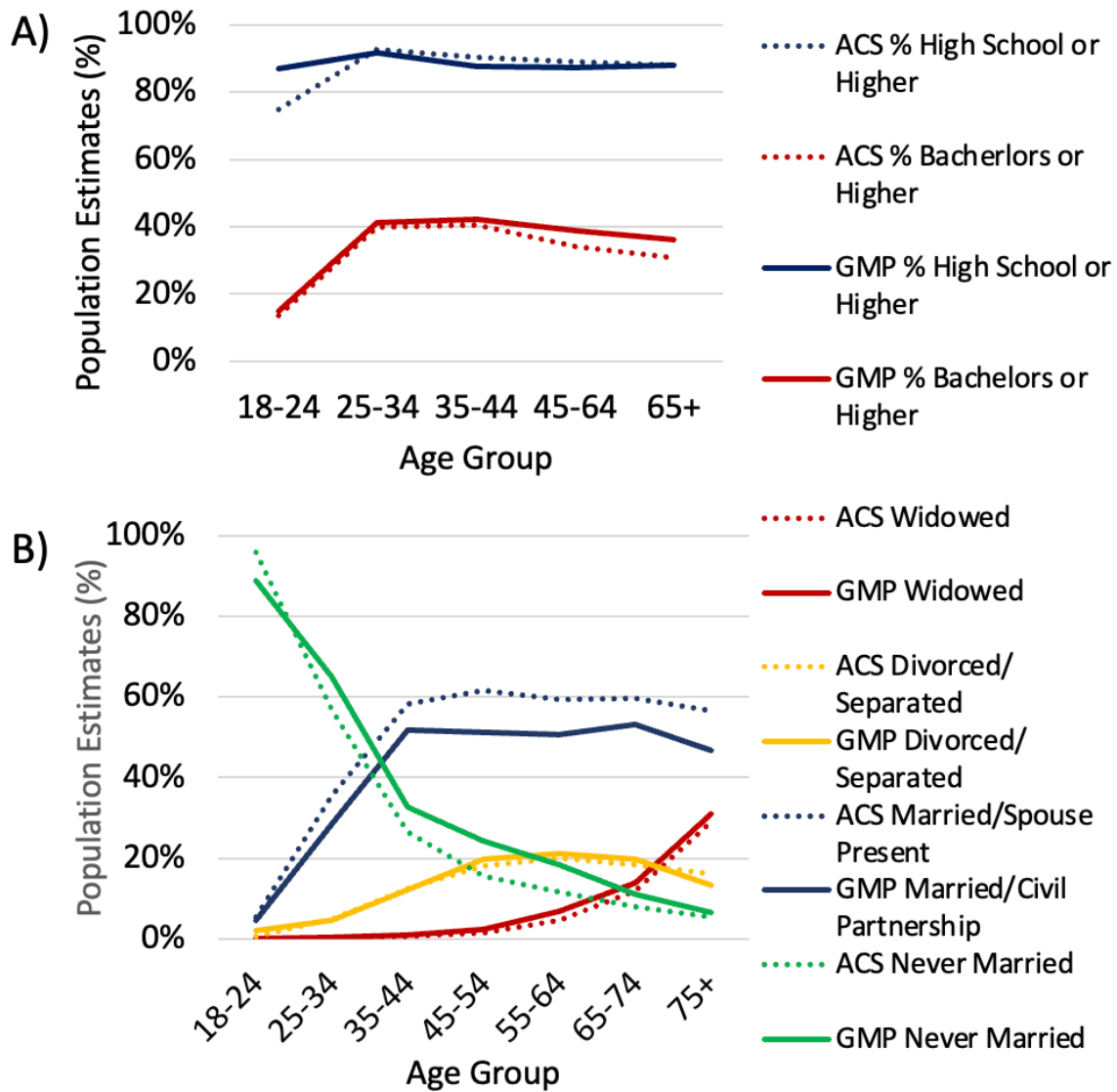

Figure 1. Comparison of population estimates (%) for educational attainment (A) and marital status (B) by age group for data obtained by ACS (N= ~3.5 M; dotted lines) and the GMP (N=25,117; solid lines) in 2022.

Reported mental health treatment seeking behavior captured in the HPS was mirrored in the GMP

Figure 2 compares trends of the percentage of the adult population seeking professional treatment for a mental health problem over time from 2020 to 2023, and by age for 2023, between the HPS and the GMP. The specific questions asked by the HPS and GMP surveys were similar but not identical. While the GMP asks about 'current' treatment for mental health challenges without specifying which type of treatment, HPS asks specifically whether prescription medication and/or therapy/counseling were taken in the past 4 weeks. Nonetheless, it provides a broadly similar comparison that can determine if the GMP oversamples for individuals with mental health problems. Figure 2A shows that the age-sex weighted national estimates of the GMP were within ±0.9% of the national estimates of the HPS for all years other than 2021 where it was 5.3% higher. The estimates by age for 2023 data are shown for HPS and GMP in Figures 2B and 2C respectively. HPS data tables use different age categories (e.g. 30-39, 40-49 rather, than 35-44, 45-54 etc.) precluding a direct comparison. However, broadly, the percentage seeking treatment in the GMP data was generally higher for ages 25-54 by an average of 7.9% (range 5.7% to 9.6%) and lower for ages 70 and above by an average of 5.2% (range 3.8% to 6.6%). This difference could arise because the GMP responses consider any treatment beyond prescription medication and therapy/counseling. However, it may also arise from a non-response bias where younger people in treatment were more likely to take part in the GMP while older people in treatment may be less likely to be on the Internet.
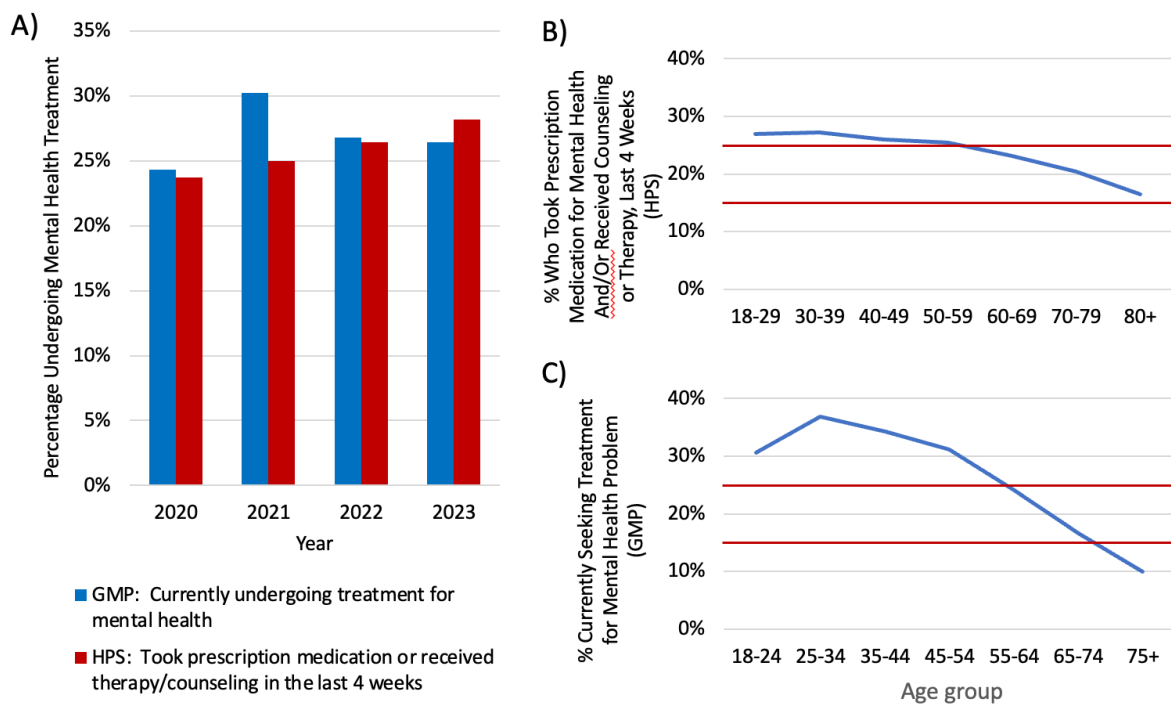
Figure 2. Comparison of trends for the percentage of the adult population seeking professional treatment for a mental health problem over time and by age between the HPS and the GMP. (A) Comparison of the percentage currently undergoing treatment for mental health problem

(GMP, blue) and the percentage who took prescription medication or received therapy/counseling in the last 4 weeks (HPS, red) from 2020 to 2023. (B) HPS data across different age groups for the percentage who took prescription medication for mental health conditions and/or received counseling or therapy in last 4 weeks in 2023. (C) GMP data across different age groups for the percentage currently seeking treatment for mental health problem in 2023.

National trends of close friendships in the ATP compared to GMP

Figure 3 shows a comparison of the number of close friends reported in the ATP in July 2023 compared to the annual GMP data for 2023. While the pattern across number of friends was similar, there were some key differences. Respondents in the GMP sample were more likely to report only 2 close friends or less (average 14.7%) compared the ATP (average 9.7%; difference 5.1%) and correspondingly less likely to report 5+ friends (27.7%) compared to the ATP (38.0%; difference 10.3%). The differences may arise for multiple reasons including differences in the estimation methods or differences in the nature of non-response bias between the two surveys.
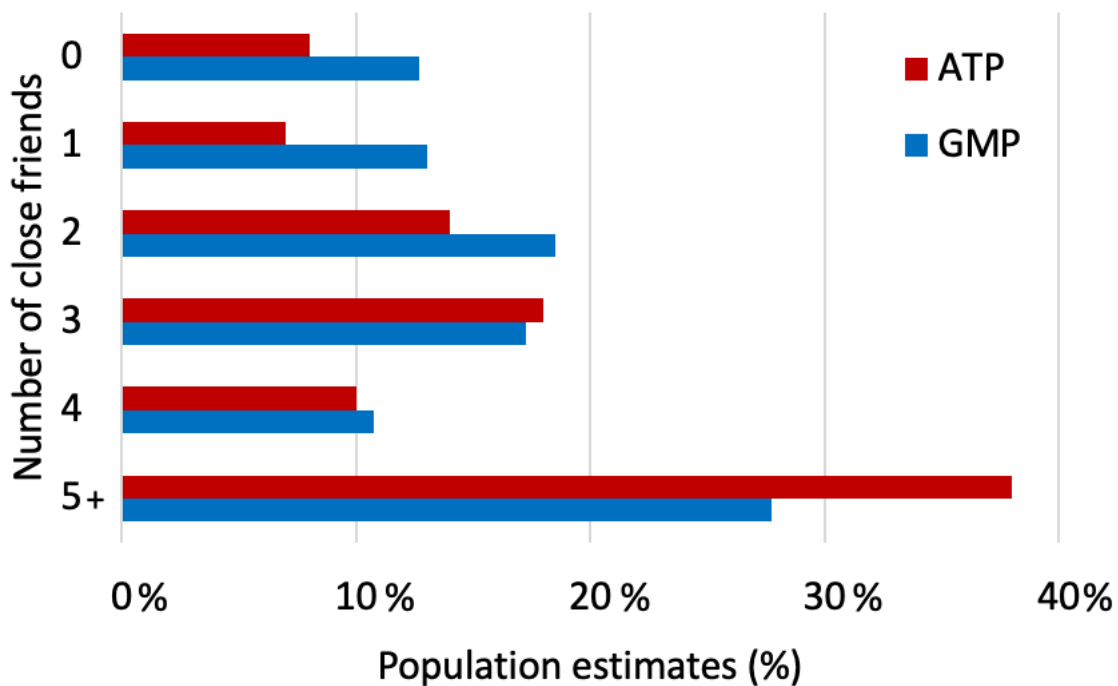
Figure 3: Comparison of population estimates (%) for the number of close friends (0 to 5+) reported in the ATP in July 2023 (red) compared to the annual GMP data for 2023 (blue).

Discussion

Principle results

This study provides an overview of the representativeness of the Global Mind Project with regard to a variety of key characteristics in comparison with the general US population using data from nationally representative surveys. Overall, we show that GMP data from the US closely mirrors national trends obtained from various rigorously stratified and randomly sampled US based surveys such as the ACS and HPS conducted by the US Census Bureau, and the ATP conducted by Pew Research Centre. This includes demographic factors of marital status and educational attainment, mental healthcare trends and friendship which represent a diverse range of variables. Altogether this suggests that data obtained anonymously through a dynamically responsive online recruitment method aligns well with national data obtained from identified participants recruited through rigorous probability sampling methods and can be reliably used to explore relationships between factors in the general population. This has particular importance given the challenges with many probability survey approaches (e.g. logistically complex, time intensive, expensive, increasing non-response rates, difficult to scale globally [29–33]) and the advantages of the GMP recruitment methodology. In particular, the GMP is able to rapidly recruit participants (1000-2000 people take part globally every day), is ten to twenty times more cost effective (average cost per respondent ranges from $0.05 to $1.5 depending on country), has global scalability (it currently runs in 71+ countries), is adaptive to changing societal trends and events, and is readily able to target specific populations of interest. Furthermore, when asking about potentially sensitive or stigmatizing issues, such as those relating mental health, anonymity is needed to address concerns over data privacy or fear of self-disclosure. It also positions the GMP as an easily scalable and flexible platform for tracking national trends, and in particular emerging trends. The findings also contribute to the growing body of literature that highlights the opportunity of using online channels such as Facebook and Google Ads to recruit participants for health-related studies, especially when targeting is carefully considered and dynamically updated based on real-time demographic profiling of the data sample [12,13,15,34].

Representativeness of the data

Although the GMP data closely mirrored national trends, it is also important to note some differences arising between the datasets that need to be considered. In the GMP data there were more single people (as compared to the ACS), more people seeking treatment in the age groups between 25-54 (as compared to the HPS) and a higher proportion with fewer friends (as compared to the ATP). These differences were on an order of magnitude of 5-7%. This suggests that either GMP captured more single people with fewer friends who were seeking mental health treatment or, conversely, captured less married people with lots of friends who were not seeking mental health treatment (or both). This latter finding aligns with other studies involving mental health surveys that report a greater representation of people with mental health problems within the sample [15,35]. Although the GMP project uses a range of recruitment key words to capture a broad spectrum of the general population, the advertisement mentions mental wellbeing which could potentially explain some of this bias. However other explanations are also possible. For example, with respect to the HPS, the GMP considers all treatments for

mental health and not just prescription medication and therapy/counseling. It is thus possible that some fraction of the difference comprises the percentage undergoing other types of treatment (e.g. brain stimulation, neurofeedback, TMS). With respect to the differences in trends for the number of close friends one possibility might be that people who frequent social media channels may have fewer close friends. However, it's also important to note that the ATP recruits participants for a broader survey of civic trends. It is therefore possible that those who agree to participate in the ATP are more civic minded which biases towards people with more friends.

Nonetheless, while the above likely explain and mitigate some of the differences observed, a small bias in the data towards those with greater risk factors for mental health challenges cannot be ruled out. One of the primary goals of the GMP is to track country level trends across the globe, particularly with respect to mental health status. The question therefore arises as to how much a 5-7% bias towards single people, those with few friends and/or those taking prescription medication or in therapy would potentially shift these estimates. For example, the difference in the percentage of those who are mentally distressed or struggling [as measured by the MHQ score, see [36–38] for more details on the MHQ how it is calculated] among those seeking treatment versus those not seeking treatment is only 14% (40% vs 26%). The average percentage of those distressed or struggling (MHQ scores<0) re-weighted by the proportions of those single and seeking treatment in each age group, as per the ACS and HPS respectively, results in a value 1-2% lower for most age groups, providing an estimate of the magnitude of this potential bias. Altogether, this suggests that national trends of the percentage Distressed or Struggling in the GMP are overestimated by up to 2%, particularly for middle age groups. However, as the recruitment methods are relatively stable each year, changes over time would still provide a reliable estimate of the magnitude of change.

Global Mind Project as a specialized case

It is important to point out, however, that these results do not mean that all internet-based surveys using online recruitment strategies are representative. Many studies still report biases, (e.g. [35]) and emphasize the need for careful targeting and ad creation. In contrast to many online surveys, the GMP uses a highly complex and dynamic optimization of targeting, key words and other factors for each source to recruit a sufficiently broad-based sample not just by demographics, but by other factors of interest. In doing so, the aim is to reduce bias caused by overrepresentation of specific samples (e.g. younger, female, better educated populations, higher prevalence of mental health conditions [15,35]). For example, if recruitment were carried out through advertisements served to people searching for information on mental health disorders, while response rates may be higher [15], the mental wellbeing profiles would skew towards worse mental health than the general population, and therefore the percentage seeking mental health treatment would be higher than national statistics reported by the HPS. The strategies of the GMP have thus been optimized by multiple experiments and involve a large number of recruitment ads (currently 800+ globally) with diverse targeting that are actively managed to accomplish these results.

Extrapolating beyond the United States

The GMP presently operates in 14 languages across 71 countries, although sample sizes vary across countries. While it is not possible to directly extrapolate these conclusions to all other countries, it is noted that the same methodology is used across the world, suggesting similar outcomes. However, it must also be noted that the GMP recruits only from the Internet-enabled population. With 94% of the US population Internet enabled, most of the population in the US are covered and may be invited to participate. In contrast, the GMP data will increasingly deviate from a nationally representative view with decreasing Internet penetration and, for countries with substantially lower internet penetration, can be considered representative only of the Internet-enabled subset. In future, studies could present results for other country datasets against nationally available statistics of internet-connected populations, also noting that there is currently very little comparative statistics on the online populations of non-western countries [39].

In conclusion

Altogether, with rising rates of mental health conditions around the world, especially in younger populations [40,41], there is an urgent need for a new paradigm of data collection within the field of mental health, something also noted by Sanchez and colleagues [39] who stated *"Developing new strategies to increase recruitment for mental health research is essential to addressing the field's most pressing problems."* Here, the potential of a dynamically stratifying sampling approach that shows good alignment with more rigorous sampling techniques used in the ACS, HPS and ATP has been demonstrated, indicating that GMP data from the US are broadly representative of the national population and positioning the project as a rapidly scalable real-time view of mental health and wellbeing as well as demographic and social trends.

Conflicts of Interest

None declared

Abbreviations

ACS: American Community Survey

ATP: American Trends Panel

CDC: Centers for Disease Control and Prevention

GMP: Global Mind Project

HPS: Household Pulse Survey

MHQ: Mental Health Quotient

US: United States

References

1. Data Reportal. Digital around the world. 2023. Available from: https://datareportal.com/global-digital-overview

2. Goel S, Obeng A, Rothschild D. Non-Representative Surveys: Fast, Cheap, and Mostly Accurate. Working Paper 2016;

3. Pedersen ER, Kurz J. Using Facebook for Health-related Research Study Recruitment and Program Delivery. Curr Opin Psychol 2016 May;9:38–43. PMID:26726313

4. Baker R, Brick JM, Bates NA, Battaglia M, Couper MP, Dever JA, Gile KJ, Tourangeau R. Summary Report of the AAPOR Task Force on Non-probability Sampling. Journal of Survey Statistics and Methodology 2013 Nov 1;1(2):90–143. doi: 10.1093/jssam/smt008

5. Birnbaum MH. Human Research and Data Collection via the Internet. Annu Rev Psychol 2004 Feb 1;55(1):803–832. doi: 10.1146/annurev.psych.55.090902.141601

6. Cornesse C, Blom AG. Response Quality in Nonprobability and Probability-based Online Panels. Sociological Methods & Research 2020 May 6;004912412091494. doi: 10.1177/0049124120914940

7. Couper MP. Review: Web Surveys: A Review of Issues and Approaches*. Public Opinion Quarterly 2000 Feb 1;64(4):464–494. doi: 10.1086/318641

8. Couper MP. Issues of Representation in eHealth Research (with a Focus on Web Surveys). American Journal of Preventive Medicine 2007 May 1;32(5, Supplement):S83–S89. doi: 10.1016/j.amepre.2007.01.017

9. Dutwin D, Buskirk TD. Apples to Oranges or Gala versus Golden Delicious?: Comparing Data Quality of Nonprobability Internet Samples to Low Response Rate Probability Samples. Public Opinion Quarterly 2017 Apr 1;81(S1):213–239. doi: 10.1093/poq/nfw061

10. Fricker RD. Sampling Methods for Online Surveys. The SAGE Handbook of Online Research Methods 1 Oliver's Yard, 55 City Road London EC1Y 1SP: SAGE Publications Ltd; 2017. p. 162–183. doi: 10.4135/9781473957992.n10

11. Kennedy C, Mercer A, Keeter S, Hatley N, McGeeney K, Gimenez A. Evaluating Online Nonprobability Surveys. 2016;

12. Schneider D, Harknett K. What's to Like? Facebook as a Tool for Survey Data Collection. Sociological Methods & Research 2022 Feb;51(1):108–140. doi: 10.1177/0049124119882477

13. Thornton L, Batterham PJ, Fassnacht DB, Kay-Lambkin F, Calear AL, Hunt S. Recruiting for health, medical or psychosocial research using Facebook: Systematic review. Internet Interventions 2016 May;4:72–81. doi: 10.1016/j.invent.2016.02.001

14. Whitaker C, Stevelink S, Fear N. The Use of Facebook in Recruiting Participants for Health Research Purposes: A Systematic Review. Journal of Medical Internet Research 2017 Aug 28;19(8):e7071. doi: 10.2196/jmir.7071

15. Batterham PJ. Recruitment of mental health survey participants using Internet advertising: content, characteristics and cost effectiveness. Int J Methods Psychiatr Res 2014 Feb 24;23(2):184–191. PMID:24615785

16. Kapp JM, Peters C, Oliver DP. Research Recruitment Using Facebook Advertising: Big Potential, Big Challenges. J Canc Educ 2013 Mar 1;28(1):134–137. doi: 10.1007/s13187-012-0443-z

17. Kayrouz R, Dear BF, Karin E, Titov N. Facebook as an effective recruitment strategy for mental health research of hard to reach populations. Internet Interv 2016 May;4:1–10. PMID:30135786

18. Zhang B, Mildenberger M, Howe PD, Marlon J, Rosenthal SA, Leiserowitz A. Quota sampling using Facebook advertisements. PSRM 2020 Jul;8(3):558–564. doi: 10.1017/psrm.2018.49

19. Glazer JV, MacDonnell K, Frederick C, Ingersoll K, Ritterband LM. Liar! Liar! Identifying eligibility fraud by applicants in digital health research. Internet Interv 2021 Sep;25:100401. PMID:34094883

20. Wang J, Calderon G, Hager ER, Edwards LV, Berry AA, Liu Y, Dinh J, Summers AC, Connor KA, Collins ME, Prichett L, Marshall BR, Johnson SB. Identifying and preventing fraudulent responses in online public health surveys: Lessons learned during the COVID-19 pandemic. PLOS Glob Public Health 2023;3(8):e0001452. PMID:37610999

21. US Census Bureau. American Community Survey (ACS). 2023. Available from: https://www.census.gov/programs-surveys/acs

22. US Census Bureau. Household Pulse Survey: Measuring Emergent Social and Economic Matters Facing U.S. Households. 2024. Available from: https://www.census.gov/data/experimental-data-products/household-pulse-survey.html

23. Pew Research Foundation. The American Trends Panel. 2024. Available from: https://www.pewresearch.org/our-methods/u-s-surveys/the-american-trends-panel/

24. Sapien Labs. Mental Health Quotient. 2024. Available from: https://sapienlabs.org/mhq/

25. US Census Bureau. American Community Survey (ACS) - Response Rates. 2023. Available from: https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/response-rates/

26. United Nations. World Population Prospects 2022. 2022. Available from: https://population.un.org/wpp/

27. US Census Bureau. American Community Survey Data. 2023. Available from: https://www.census.gov/programs-surveys/acs/data.html

500 28. CDC. Mental Health Care: Household Pulse Survey. 2022. Available from:
501   https://www.cdc.gov/nchs/covid19/pulse/mental-health-care.htm

502 29. Kohut A, Keeter S, Doherty C, Dimock M, Christian L. Assessing the Representativeness
503   of Public Opinion Surveys. Pew Research Centre For the People and the Press 2012;

504 30. US Government Accountability Office. The American Community Survey: Accuracy and
505   Timeliness Issues. 2002. Available from: https://www.gao.gov/products/gao-02-956r

506 31. Brick JM, Williams D. Explaining Rising Nonresponse Rates in Cross-Sectional Surveys.
507   The ANNALS of the American Academy of Political and Social Science SAGE
508   Publications Inc; 2013 Jan 1;645(1):36–59. doi: 10.1177/0002716212456834

509 32. Keeter S, Kennedy C, Dimock M, Best J, Craighill P. Gauging the Impact of Growing
510   Nonresponse on Estimates from a National RDD Telephone Survey. Public Opinion
511   Quarterly 2006 Jan 1;70(5):759–779. doi: 10.1093/poq/nfl035

512 33. Leeper TJ. Where Have the Respondents Gone? Perhaps We Ate Them All. Public
513   Opinion Quarterly 2019 Jul 19;83(S1):280–288. doi: 10.1093/poq/nfz010

514 34. Astley CM, Tuli G, Mc Cord KA, Cohn EL, Rader B, Varrelman TJ, Chiu SL, Deng X,
515   Stewart K, Farag TH, Barkume KM, LaRocca S, Morris KA, Kreuter F, Brownstein JS.
516   Global monitoring of the impact of the COVID-19 pandemic through online surveys
517   sampled from the Facebook user base. Proc Natl Acad Sci U S A 2021 Dec
518   21;118(51):e2111455118. PMID:34903657

519 35. Lee S, Torok M, Shand F, Chen N, McGillivray L, Burnett A, Larsen ME, Mok K.
520   Performance, Cost-Effectiveness, and Representativeness of Facebook Recruitment to
521   Suicide Prevention Research: Online Survey Study. JMIR Ment Health 2020 Oct
522   22;7(10):e18762. PMID:33090115

523 36. Newson JJ, Pastukh V, Thiagarajan TC. Assessment of Population Well-being With the
524   Mental Health Quotient: Validation Study. JMIR Ment Health 2022 Apr
525   20;9(4):e34105. doi: 10.2196/34105

526 37. Newson JJ, Sukhoi O, Thiagarajan T. MHQ: Constructing an aggregate metric of mental
527   wellbeing. 2023; Available from: https://osf.io/preprints/osf/d47qj [accessed Dec 18,
528   2023]

529 38. Newson JJ, Thiagarajan TC. Assessment of Population Well-Being With the Mental
530   Health Quotient (MHQ): Development and Usability Study. JMIR Ment Health 2020 Jul
531   20;7(7):e17935. doi: 10.2196/17935

532 39. Sanchez C, Grzenda A, Varias A, Widge AS, Carpenter LL, McDonald WM, Nemeroff
533   CB, Kalin NH, Martin G, Tohen M, Filippou-Frye M, Ramsey D, Linos E, Mangurian
534   C, Rodriguez CI. Social media recruitment for mental health research: A systematic
535   review. Compr Psychiatry 2020 Nov;103:152197. PMID:32992073

536 40. Sapien Labs. Mental State of the World 2020. 2021 Mar. Available from:
537   https://mentalstateoftheworld.report/msw-2020/

538   41. Twenge JM, Cooper AB, Joiner TE, Duffy ME, Binau SG. Age, period, and cohort trends
539   in mood disorder indicators and suicide-related outcomes in a nationally representative
540   dataset, 2005–2017. Journal of Abnormal Psychology 2019 Apr;128(3):185–199. doi:
541   10.1037/abn0000410

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