Sample Representativeness Postprint in Psychological and Brain Sciences Research

Authors: Liu Weibiao, Chen Zhiyi, Hu Chuanpeng, Hu Chuanpeng

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Abstract

Psychology and brain sciences, which employ human subjects as research participants, have the generalizability of their findings (also referred to as universality) largely contingent upon the representativeness of their samples. However, the representativeness of samples in psychological and brain sciences research has long been subject to criticism. Two major issues currently exist in the literature: (1) Incomplete sample information—most studies report only participants' gender, age, and nationality, whereas crucial information such as participants' race/ethnicity, educational attainment, and socioeconomic status is seldom reported, and temporally, this situation has not fundamentally improved compared to the past; (2) Based on reported information, current samples exhibit insufficient representativeness: female participants outnumber male participants, with samples concentrated among Western, young, and highly educated populations, while middle-aged and elderly individuals, populations with lower educational levels, and low-income groups receive limited attention from researchers, and Asian/Asian American, Black/African American, and Hispanic/Latino populations similarly receive insufficient attention; from a national perspective, populations from Asian, African, and Latin American countries, particularly those from Africa, Latin America, and the Middle East, are underrepresented in psychological and brain sciences research. The emergence of these two major issues may be primarily attributed to the following factors: convenience sampling as the predominant sampling method; the dominance of European and American researchers in psychological and brain sciences research; a general neglect of cultural and diverse demographic factors; and inherent biases among researchers. Changing this status quo requires concerted efforts from multiple stakeholders, including researchers, academic organizations, journal editors, and funding agencies. Enhancing sample representativeness will facilitate the application of scientific knowledge from psychology and brain sciences to broader populations, thereby advancing the construction of a community with a shared future for mankind.

Full Text

Sample Representativeness in Psychological and Brain Science Research

Weibiao Liu[1], Zhiyi Chen[2], Chuan-Peng Hu[1]*

[1]Department of Psychology, Nanjing Normal University, Nanjing, 210097, China
[2]Faculty of Medical Psychology, Army Medical University, Chongqing, 400038, China

*Corresponding author: Chuan-Peng Hu, email: hu.chuan-peng@nnu.edu.cn

Abstract: Psychological and brain sciences study human participants, and the generalizability of their findings depends critically on sample representativeness. However, sample representativeness in psychological and brain science research has long been criticized. Current research exhibits two major problems: (1) incomplete reporting of sample information—most studies only report participants' gender, age, and nationality, while important information such as race/ethnicity, education level, and socioeconomic status is seldom reported, and this situation has not fundamentally improved over time; (2) insufficient representativeness among reported information—female participants outnumber males, and samples concentrate on Western, young, and highly educated populations, while middle-aged and older adults, less educated individuals, and low-income groups receive less attention. Asian/Asian American, Black/African American, and Hispanic/Latino populations are also underrepresented. From a national perspective, populations from Asian, African, and Latin American countries, especially those in Africa, Latin America, and the Middle East, rarely appear in psychological and brain science research. These issues likely stem from four main causes: convenience sampling as the primary method; Western researchers' dominance in the field; overall neglect of cultural and demographic factors; and researchers'own biases. Changing this situation requires joint efforts from researchers, academic organizations, journal editors, and funding agencies. Improving sample representativeness will help apply psychological and brain science knowledge to broader populations and promote the building of a global community with a shared future.

Keywords: Population psychology, Sample representativeness, Diversity, Generalizability, Systematic review

The ultimate goal of psychological and brain sciences is to understand the laws of human mind and behavior at both behavioral and neurobiological levels. Therefore, most studies use human volunteers as participants. To achieve this goal, research conclusions should be generalizable [1], which requires that participant samples represent the target population—all of humanity. Conversely, unrepresentative samples can lead to a crisis of generalizability in psychology [1-3]. In recent years, developmental population neuroscience has made significant progress in increasing sample representativeness by examining neural development across the entire lifespan [4-6]. In the context of building a global com-

munity with a shared future, understanding the psychological and brain science laws of all humanity is of great significance.

Sample representativeness in psychological and brain science has long been criticized. As early as 1986, Sears found that over 70% of samples in three major social psychology journals came from American college students [7], leading psychology to be dubbed "the science of college sophomores."More than two decades later, Arnett [8] analyzed six major psychology journals and found that their samples primarily came from Europe and America, especially the United States. Subsequently, in 2010, Henrich et al. [9] proposed that psychological research mainly draws from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) populations, which represent only a small fraction of humanity. Following the publication of the WEIRD article and the emergence of psychology' s reproducibility crisis, researchers have increasingly recognized the importance and severity of sampling issues. However, it should be noted that using the simple acronym WEIRD to refer to representativeness issues, while widely disseminated in the English-dominated international academic community, essentially reflects a Western-centric perspective that ignores the diversity and complexity of non-Western societies [10,11]. Since then, a series of meta-researches on sample representativeness have been published (e.g., [11–14]), analyzing sample representativeness from different journals or research topics. However, from the perspective of psychological and brain science as a whole, information on sample representativeness remains lacking.

To understand the current state of human samples in psychological and brain science, this study systematically reviews meta-researches on sample representativeness, focusing on two aspects: (1) the reporting of human sample information in psychological and brain science literature; (2) the representativeness of reported sample information. Additionally, this study systematically summarizes the main causes of unrepresentative samples and proposes corresponding solutions.

This study follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 statement [15,16] for literature search, screening, and inclusion. Search keywords and databases are detailed in Supplementary Material 1.1, with the final search date being May 22, 2024. To ensure comprehensive inclusion, we supplemented with additional literature discovered through Google Scholar searches and while reading articles, obtaining a total of 618 articles. Inclusion criteria and screening details are provided in Supplementary Material 1.1. After systematic screening, 102 articles were ultimately included (see Figure 1). Inter-rater agreement between two independent coders reached a generally good level (title and abstract screening: Cohen' s Kappa = 0.60; full-text screening: Cohen's Kappa = 0.43), with all discrepancies resolved through discussion.

[Figure 1: see original paper]

1 Demographic Information Reported in Psychological and Brain Science Research

Assessing sample diversity and representativeness requires detailed reporting of participant information. According to the seventh edition of the American Psychological Association Publication Manual, quantitative empirical studies should report demographic information including gender, age, race/ethnicity, education level, socioeconomic status (SES), gender identity, sexual orientation, etc. [17]. If a study fails to report detailed demographic characteristics, readers cannot evaluate its sample' s basic features or representativeness. Analyzing what information is reported in psychological and brain science research can reflect researchers' perceptions of which demographic information is important. Existing meta-researches indicate insufficient attention to most demographic information (detailed coding of reported sample information in meta-researches is available in online Supplementary Table S2).

1.1 Gender

Gender (sex/gender; sex refers to biological sex, while gender refers to socially constructed attitudes, behaviors, and feelings associated with culture and biological sex [17]; since relevant meta-researches did not distinguish between sex and gender during coding, we do not differentiate them here) is the most salient demographic information, and gender differences themselves are important topics in psychological and brain science research [18,19]. For example, individual differences in personality [20], cognitive abilities [21], helping behavior [22], and mental health [23] across genders have received considerable attention. Current analyses show that nearly all studies report sample gender information (see Figure 2a [Figure 2: see original paper], average reporting proportion = 88.0%, 95% CI [82.7%, 92.4%]; proportion meta-analysis estimation methods are detailed in Supplementary Material 1.2, same below).

For instance, Hendriks et al. [24] analyzed 188 randomized controlled trials of positive psychological interventions published between 1998-2017, finding that 96.3% reported gender; Rad et al. [13] analyzed 428 studies published in the general journal *Psychological Science* in 2014, finding that 75% reported gender; Ghai et al. [11] analyzed 34 studies on the relationship between adolescent depression and social media use published between 2018-2020, finding that all reported gender.

Regarding temporal trends, the proportion of gender reporting has changed minimally (see Figure 3a [Figure 3: see original paper]). For example, among 1,244 studies published in the *Journal of Psychopathology and Clinical Science* (formerly *Journal of Abnormal Psychology*), gender reporting increased slightly from 91.18% in 1995-1999 to 92.81% in 2005-2009 and 96.91% in 2015-2019 [14]; among 1,762 studies published in eight major journals focusing on intimate relationships, gender reporting increased slightly from 70.5% in 1996-2000 to 74.6% in 2016-2020 [25]; in the neuroscience journal *Psychophysiology*, gender

reporting proportions showed minimal temporal change among 1,500 studies published between 2010-2020 [12].

1.2 Age

Age is also an important variable in psychological and brain science research and is one of the most studied variables in developmental population neuroscience. For example, the "Chinese Color Nest Project" focuses on age-related changes in human brain development [26]. Current analyses show that nearly all studies report age information (see Figure 3b, average reporting proportion = 89.6%, 95% CI [82.0%, 95.4%]). Specifically, age reporting proportions are higher in fields closely related to participant age, such as developmental psychology, mental health, and intimate relationships. For example, Ghai et al. [11] found that all 34 studies on adolescent depression and social media use published between 2018-2020 reported age; Williamson et al. [27] analyzed 771 studies published in five major journals on intimate relationships between 2014-2018, finding that 92% reported age. In contrast, general journals show relatively lower age reporting proportions—for example, Rad et al. [13] found that only 69.4% of 428 studies published in *Psychological Science* in 2014 reported age; Scholtz [28] analyzed 139 convenience sampling studies published in three major African psychology journals between 2018-2020, finding that only 42.4% reported age.

Regarding temporal trends, age reporting proportions have changed minimally (see Figure 3b). For example, among 1,244 studies in *Journal of Psychopathology and Clinical Science*, age reporting increased slightly from 90.37% in 1995-1999 to 95.92% in 2005-2009 and 97.57% in 2015-2019 [14]; in *Psychophysiology*, the average age reporting proportion increased significantly over time among 1,500 studies published between 2010-2020 [12].

1.3 Country

Country represents cultural background and is crucial in psychological and brain science. Individual cultural differences manifest not only in familiar social psychology and behavior but also in basic cognitive processes [29] and brain mechanisms [30]. Current analyses show that nearly all studies report country information (see Figure 2c, average reporting proportion = 94.7%, 95% CI [88.2%, 98.8%]). For example, Hendriks et al. [24] found that 96.3% of 188 positive psychological intervention RCTs published between 1998-2017 reported country; Rad et al. [13] found that 89% of 428 studies published in *Psychological Science* in 2014 reported country; Nielsen et al. [31] found that 99% of 1,582 studies published in three developmental psychology journals between 2006-2010 reported country.

Regarding temporal trends, country reporting proportions have changed minimally overall (see Figure 3c). For example, in the environmental psychology journal *Journal of Environmental Psychology*, country reporting increased slightly from 85.4% in 2014 (137 studies) to 81.54% in 2017 (65 studies) [32];

among 1,762 intimate relationship studies published in eight major journals, country reporting decreased slightly from 59.4% in 1996-2000 to 56.5% in 2016-2020 [25]; in *Psychophysiology*, all 1,500 studies published between 2010-2020 reported country, with the reporting proportion remaining constant over time [12].

A notable phenomenon in country reporting: studies conducted in Western countries like the United States and United Kingdom rarely include country information in titles, whereas studies conducted in other countries typically specify country in titles. Kahalon et al. [33] analyzed 855 articles published in four social psychology journals between 2015-2017, finding that only 5.9% of articles with U.S. samples and 8.9% with samples from other Western countries mentioned country in titles, compared to 47.5% of articles with non-Western samples. This pattern suggests that in current international psychological and brain science research, Western—especially American—samples are considered the "default human sample" requiring no additional specification, while non-Western samples are not considered default and require explicit notation.

1.4 Race/Ethnicity

Race/ethnicity represents a more granular cultural unit than country and is vital demographic information in psychological and brain science. It implicitly reflects individuals' cultural backgrounds and profoundly influences how they think and act in the social world [34]. Current analyses show that only about half of studies report race/ethnicity (see Figure 2e, average reporting proportion = 53.0%, 95% CI [42.7%, 63.1%]). Specifically, studies based on American samples show higher race/ethnicity reporting proportions. For example, Burnette et al. [35] analyzed 58 U.S. studies on eating disorder psychotherapy, finding that 74.1% reported race; Peter et al. [36] analyzed U.S. RCTs on gambling disorder, finding that 92% reported race. In contrast, meta-research without country restrictions shows lower race/ethnicity reporting proportions. For example, Gallegos-Riofrío et al. [37] analyzed 174 studies on nature' s mental health effects published between 2010-2020, finding that only 25% reported race/ethnicity; Rad et al. [13] found that only 20% of 428 studies published in *Psychological Science* in 2014 reported race/ethnicity. More specific analyses also reveal higher race/ethnicity reporting in U.S. samples compared to other countries. For example, among 62 internet-based cognitive behavioral therapy RCTs published between 1966-2018, 88% of U.S. samples reported race versus only 4% of other countries' samples, and 53% of U.S. samples reported ethnicity versus only 6% of other countries' samples [38]. Notably, neuroscience articles report race/ethnicity even less frequently—for example, only 3.7% of 536 studies published in *Cerebral Cortex* and *NeuroImage* in 2019 reported race [39]. Even for U.S. samples, only 10% of 408 fMRI studies published between 2010-2020 reported race and 4% reported ethnicity [40].

Regarding temporal trends, race/ethnicity reporting proportions have increased substantially in some fields (see Figure 2e). For example, among 1,244 studies in

Journal of Psychopathology and Clinical Science, race reporting increased from 41.98% in 1995-1999 to 60.91% in 2005-2009 and 63.58% in 2015-2019, while ethnicity reporting increased from 16.04% to 29.02% to 30.46% [14]; in infant research, race reporting increased from 31% in 2010-2013 to 64% in 2014-2017 [41].

1.5 Education Level

Education level is important demographic information that influences multiple aspects of psychological and behavioral performance [9]. For example, compared to highly educated Americans, those without higher education score lower on individualism [42], show conformity motivations similar to Eastern societies [43,44], rationalize their choices less after cognitive dissonance [45], and support racial diversity less [46]. Current analyses show that only about half of studies report education level information (see Figure 2d, average reporting proportion = 58.6%, 95% CI [41.1%, 75.0%]). Specifically, educational psychology—a field closely related to education level—shows relatively high reporting proportions. For example, Richmond et al. [47] analyzed 312 studies published in four teaching psychology journals between 2008-2013, finding that 97.4% reported education level. Other fields show lower reporting proportions—for example, Hendriks et al. [24] found that only 52.1% of 188 positive psychological intervention RCTs published between 1998-2017 reported education level; Rad et al. [13] found that only 52% of 428 studies published in *Psychological Science* in 2014 reported education level.

Regarding temporal trends, education level reporting proportions have changed minimally (see Figure 3d). For example, among 1,244 studies in *Journal of Psychopathology and Clinical Science*, education level reporting increased from 47.33% in 1995-1999 to 51.08% in 2005-2009, then decreased to 44.59% in 2015-2019 [14]; in *Psychophysiology*, education level reporting proportions showed no significant temporal change among 1,500 studies published between 2010-2020 [12].

1.6 Socioeconomic Status

Socioeconomic status (SES) reflects individuals' material and non-material resources and their overall position in society [48]. Many studies treat SES as a composite of income, occupation, and education level [49], while more studies treat SES specifically as personal/family income or subjective social class, separate from education and occupation—this study adopts the latter approach. Individual SES has garnered considerable research attention due to its substantial impact on human psychology, behavior, and brain structure and function [49,50]. For example, under high working memory load, students from high-income families show greater activation in frontal and parietal brain regions closely related to working memory and demonstrate better working memory performance compared to low-income students [51]. Current analyses show that only a small proportion of studies report SES information (see Figure 2f, average report-

ing proportion = 34.0%, 95% CI [21.3%, 48.0%]). Specifically, developmental psychology—which emphasizes family SES—shows relatively high reporting proportions. For example, Raad et al. [52] analyzed 206 studies published in five developmental psychology journals in 2005, finding that 57.3% reported SES; Singh & Rajendra [53] analyzed 1,576 studies published in six developmental psychology journals between 2015-2020, finding that 46% reported SES. Other fields report SES less frequently—for example, Williamson et al. [27] found that only 24% of 771 intimate relationship studies published in five major journals between 2014-2018 reported SES; Rad et al. [13] found that only 8% of 428 studies published in *Psychological Science* in 2014 reported SES.

Regarding temporal trends, SES reporting proportions have changed minimally (see Figure 3f). For example, among 1,244 studies in *Journal of Psychopathology and Clinical Science*, SES reporting increased slightly from 17.38% in 1995-1999 to 23.02% in 2005-2009 and 24.06% in 2015-2019 [14]; in *Psychophysiology*, SES reporting proportions showed minimal temporal change among 1,500 studies published between 2010-2020 [12].

1.7 Other Demographic Variables

Occupation, religious belief, gender identity and sexual orientation, and immigration background are also important demographic variables that should not be overlooked in psychological and brain science research. Occupation, for example, is a key indicator of family economic level—approximately 62.6% of 139 studies published in three major African psychology journals between 2018-2020 reported participants' occupational information [28]. However, despite most people worldwide having religious beliefs, only 8.6% of relevant psychology studies report this information [28]. Furthermore, gender identity and sexual orientation—key variables in intimate relationship research—were reported in only 36.1% of studies published between 1996-2000 and 2016-2020 [25]. For immigrant countries, immigration background information is extremely valuable, yet only 4% of 342 clinical trials on depression in U.S. populations published between 1981-2016 mentioned this information [54]. Additionally, it should be noted that demographic information recording and reporting may be profoundly influenced by sociocultural context—variables such as rural/urban household registration, which are extremely important in China and many developing countries, are often ignored in Western-dominated psychological and brain science research [55].

[Figure 2: see original paper]
[Figure 3: see original paper]

2 Representativeness of Current Human Samples

To further understand how well samples in current psychological and brain science research represent all humanity, we analyzed and synthesized reported demographic information (detailed coding of sample representativeness in meta-

researches is available in online Supplementary Table S3) and compared it with world population data.

2.1 Gender and Age

Regarding gender, the proportion of females is slightly higher than males (see Figure 4a [Figure 4: see original paper]). For example, among 1,500 studies published in *Psychophysiology* between 2010-2020, female participants accounted for 57.8% [12]; in 188 positive psychological intervention RCTs published between 1998-2017, female participants accounted for 73.7% [24]; in the 100 studies replicated by the Open Science Collaboration, female participants accounted for 63.95% [56]; in 312 studies published in four teaching psychology journals between 2008-2013, female participants accounted for 71.48% [47]—all higher than the 49.7% female proportion in world population (data source in online Supplementary Material 3).

Regarding temporal trends, the proportion of female participants has increased over time. For example, among 1,762 studies published in eight major intimate relationship journals, the proportion of female participants increased slightly from 59% in 1996-2000 to 61% in 2016-2020 [25]; among 1,244 studies in *Journal of Psychopathology and Clinical Science*, female participant proportions first decreased slightly from 48.49% in 1995-1999 to 46.13% in 2005-2009, then increased substantially to 62.14% in 2015-2019 [14].

Regarding age, young populations predominate overall (see Figure 4b). For example, the average age was 22.99 years among 428 studies published in *Psychological Science* in 2014 [13]; 25.04 years among 1,500 studies published in *Psychophysiology* between 2010-2020 [12]; and only 21.62 years in the 100 studies replicated by the Open Science Collaboration, where over half of participants were undergraduates around 20 years old [56]. Except for a few fields where average age exceeds the world population median [24], the average age of participants in most psychological and brain science research is below the world population median age of 30 years (data source in online Supplementary Material 3).

Furthermore, meta-research on Chinese samples in psychology studies indicates that, compared to China' s seventh national census data, Chinese samples show higher proportions of female participants and predominantly consist of young people aged 15-24 [57]. In big-team science, Chinese samples exhibit characteristics of being young, highly educated, and geographically unevenly distributed [58].

2.2 Education Level and Socioeconomic Status

Regarding education level, most recruited participants have strong educational backgrounds (see Figure 4d). For example, among 428 studies published in *Psychological Science* in 2014, 67.7% of participants had higher education [24]; in 188 positive psychological intervention RCTs published between 1998-2017, 72.4% of participants had higher education [24]. In contrast, only 15.77% of the

world population in 2020 had higher education; in the 100 studies replicated by the Open Science Collaboration, at least 54.51% of participants were undergraduates [56]. Moreover, meta-research reporting years of education found that participants' average education years exceed world averages. For example, the average education years was 14.11 among 1,500 studies published in *Psychophysiology* between 2010-2020 [12], substantially higher than the world population average of 8.84 years (data source in online Supplementary Material 3).

Regarding socioeconomic status, low-income participants are severely underrepresented. For example, among 771 intimate relationship studies published in five major journals between 2014-2018, 64% primarily used middle-class samples, 25% used diverse samples, and only 11% used low-income samples [27]; among 342 RCTs on depression conducted in the United States between 1981-2016, 12.7% of adult samples and 13.7% of child samples primarily consisted of low-income individuals [54]. According to the World Bank' s standard of $3.65 daily income (approximately ¥26.23 RMB), 24.13% of the world population in 2019 belonged to lower-middle-income populations (data source in online Supplementary Material 3)—higher than the proportions reported in the two meta-research studies above.

2.3 Country/Region and Race/Ethnicity

Regarding country, sampling is disproportionately high in Western countries, especially the United States, and disproportionately low in developing countries, particularly in Africa, Latin America, and the Middle East (excluding Israel) (see Figure 4c). For example, among 1,582 studies published in three developmental psychology journals between 2006-2010, 87% sampled from Western countries (68.9% from the United States), while only 4% sampled from Asian countries, 1% from African countries, 1% from Latin American countries, and 2% from Middle Eastern countries [31]; among 476 neuroimaging studies for psychiatric diagnosis published between 1990-2021, all 118,137 participants came from upper-middle-income or high-income countries, with 52.94% from Western countries, 44.12% from Asian countries, 0.21% from African countries, 2.31% from Latin American countries, and 0.42% from Middle Eastern countries [59]. In world population, Western countries in North America, Europe, and Oceania account for only 14.73% (with the U.S. accounting for 4.26%), while Asia accounts for 52.05%, Africa for 16.24%, Latin America for 8.30%, and the Middle East for 8.69% (data source in online Supplementary Material 3).

Regarding temporal trends, sampling from Western countries has decreased slightly while sampling from Asian, African, and Latin American countries has increased slightly. For example, among 428 studies published in *Psychological Science* in 2014, 93.4% of samples came from Western countries (57.3% from the United States), while only 4.3% came from Asian countries (excluding Israel), 0.8% from South American countries, and 1.5% from African countries. Three years later in 2017, Western country sampling decreased to 90.8%

(with U.S. sampling increasing to 63.2%), Asian country sampling increased to 9.2%, while South American and African country sampling decreased to 0% [13]; among 2,452 studies published in six major psychology journals between 2003-2007, 97% of samples came from Western countries (68% from the United States), while only 3% came from Asian countries, with no samples from African, Middle Eastern, or Latin American countries [8]. More than a decade later, between 2014-2018, Western country sampling decreased to 94.5% (66.5% from the United States), while sampling from Asian (4.2%), African (0.4%), Latin American (0.45%), and Middle Eastern (0.5%) countries all increased [60].

Regarding race, the proportion of European-descent White individuals is excessively high, while proportions of Asian/Asian American, Black/African American, and Hispanic/Latino populations are too low (see Figure 4e). For example, in the 100 studies replicated by the Open Science Collaboration, 81.78% of participants were European-descent White, only 5.79% were Asian/Asian American, 7.67% were Black/African American, 1.28% were Hispanic/Latino, and 0.26% were other races [56]; among 1,500 studies published in *Psychophysiology* between 2010-2020, 65.5% of participants were European-descent White [12]; among 62 internet-based cognitive behavioral therapy RCTs published between 1966-2018, 74.9% of participants were European-descent White, 5.8% were Asian/Asian American, 7.6% were Black/African American, and 11.7% were other races [38]; among 1,511 articles emphasizing race published in six journals in cognitive, developmental, and social psychology between 1974-2018, excluding 10% with missing race information, 42% of participants were European-descent White and 48% were people of color [62]. Moreover, even in articles emphasizing multiracial samples, European-descent Whites remain overrepresented —for example, among 92 multiracial articles published between 2000-2020, single-race participants consisted of 55% European-descent White, 17% Asian/Asian American, 20% Black/African American, and 8% Hispanic/Latino [63]. However, in world population, European-descent Whites account for approximately 11%, Asian/Asian Americans for 52%, Black/African Americans for 15%, Hispanic/Latinos for 8%, and other ethnicities for 14% (data source in online Supplementary Material 3).

Regarding temporal trends, the proportion of European-descent White participants has decreased while other racial groups have increased. For example, among 1,244 studies in *Journal of Psychopathology and Clinical Science*, European-descent White participant proportions gradually decreased from 83.72% in 1995-1999 to 78.75% in 2005-2009 and 73.87% in 2015-2019, while Asian/Asian American proportions first decreased then increased (6.31% →3.83% →4.60%), Black/African American proportions first decreased then increased (13.87% →13.61% →16.03%), and Hispanic/Latino proportions first decreased then increased (6.93% →6.37% →7.77%) [14].

2.4 Most Neglected Populations

The above analyses examine single demographic characteristics, but each individual possesses multiple demographic features. Synthesizing these characteristics reveals that psychological and brain science samples primarily come from young, Western, highly educated European-descent White populations. Even in non-Western country studies, samples similarly concentrate on well-educated young populations. For example, among 144 articles written in Arabic by Arab authors published between 2000-2016, 51% of adult samples were college students [64]. Compared to these "mainstream" psychology samples, certain specific populations may be neglected across multiple dimensions. For example, poor middle-aged and older men in rural areas of developing countries in Asia, Africa, Latin America, and the Middle East are neglected across all demographic dimensions: gender, age, country/region, race, education, and SES. African-descent populations, even in developed countries, often have low socioeconomic status and fewer educational opportunities, making them vulnerable to neglect across race, education, and SES dimensions. These most neglected populations happen to be disadvantaged groups from a global perspective or within societies, and multiple United Nations Sustainable Development Goals (https://sdgs.un.org/goals) specifically aim to improve the physical and mental well-being of these disadvantaged groups.

3 Discussion and Outlook

The review above demonstrates that current psychological and brain science research often neglects important demographic information. Except for gender, age, and country, other demographic variables lack reporting, and this situation has not fundamentally changed over time. Based on reported information, current sampling in psychological and brain science severely lacks representativeness, with samples predominantly consisting of young, highly educated European-descent Whites from Western countries. If this situation is not addressed and changed, the generalizability of psychological and brain science research findings will inevitably remain questionable.

3.1 Causes

Based on previous research, the most direct cause of unrepresentative samples is convenience sampling as the primary method, with college students being the most convenient sample. Deeper causes include Western researchers' dominance in psychological and brain science, overall neglect of cultural and demographic factors, and researchers' own biases.

(1) **Convenience Sampling as the Primary Method**: The most direct cause is that most studies use convenience sampling, with few employing representative sampling methods. For example, among 34 studies on adolescent depression and social media use published between 2018-2020, 62% of studies from developed countries and 80% from developing coun-

tries used convenience sampling [11]. Highly educated young people, particularly college students, are often the most easily accessible group for convenience sampling due to their high cooperation and low data collection costs. This leads to psychological and brain science samples primarily coming from this highly specific population. Notably, the prevalence of convenience sampling also leads researchers to pay less attention to vulnerable groups—for example, among the 34 studies analyzed by Ghai et al. [11], only 4% of developed country studies sampled from vulnerable groups, and no developing country studies did so.

(2) **Western Researchers' Dominance in Psychological and Brain Science**: Western researchers' absolute dominance in psychological and brain science makes it unsurprising that samples primarily come from European and American countries. Among 68 major English-language psychology journals, over 90% of articles published between 2017-2019 had authors from European and American countries, with over 60% from the United States; over 95% of editorial board members were from European and American countries, with over 70% from the United States; and almost all editors-in-chief came from European and American countries, with over 70% from the United States [65]. Additionally, comparing articles published in six major psychology journals between 2003-2007 and 2014-2018 shows that both first and other authors are predominantly European and American researchers, with minimal cross-temporal differences [8,60]. The deeper reasons are that psychology historically originated in Europe and developed massively in the United States, with 72% of the 68 major psychology journals being U.S.-based [65]. Moreover, European and American countries, especially the United States, have strong economies and sufficient research funding to support psychological and brain science research [8]. Additionally, most internationally influential journals in related fields are English-language journals, and developing countries face significant language barriers as non-English-speaking nations [65].

(3) **Neglect of Cultural Background Influences**: Traditional psychological research overemphasizes universal basic psychological processes while neglecting individual difference factors, particularly cultural background influences [8]. For example, among all articles published in seven cognitive psychology journals between 2016-2020, only about 7% considered culture broadly, and most of these (83%) focused on language or bilingualism. Researchers studying basic cognitive processes may mistakenly assume that all humans share the same cognitive processes and automatically ignore or disregard cultural background influences in their projects [66]. However, extensive cultural psychology research has found significant cultural differences even in basic cognitive processes [29]. Moreover, the complexity of human culture and society far exceeds simple binary divisions like "East vs. West" [67,68], with considerable cultural variation within each broad cultural region. For example, even within the same Eastern culture of China, different regions, ethnic groups, and age cohorts may exhibit

subcultural differences [69]. Neglecting this heterogeneity prevents psychological and brain science conclusions from generalizing to unstudied populations.

(4) **Researchers' Own Biases**: The long-term dominance of European and American researchers in psychological and brain science has created substantial biases among researchers worldwide. On one hand, European and American scholars blindly assume that theories proposed by Western researchers can be generalized globally—for example, a study on civic honesty published in *Science* used measurement methods for Chinese samples that did not align with Chinese cultural context [70,71]. On the other hand, scholars from developing countries treat Western theories as gospel [72], assuming they apply to their own cultures while neglecting the development of indigenous psychology. These researcher biases reinforce European and American researchers' dominance, naturally resulting in mainstream psychology journals publishing mostly studies by European and American researchers sampling locally.

3.2 Outlook

The lack of sample representativeness in psychological and brain science is a systemic problem requiring multi-stakeholder participation and action. Researchers, academic societies, journals, and funding agencies must support and collaborate with each other to change the current situation of unrepresentative samples.

(1) **Researchers**: First, as reporting demographic information is the starting point for assessing sample characteristics, researchers should comprehensively collect and report detailed participant demographic information (if concerned about article length, this can be placed in supplementary materials). Researchers should report basic demographic information including gender, age, nationality, education level, family economic status, race/ethnicity, and rural/urban household registration, as well as other individual difference variables relevant to their research.

Second, researchers should identify target populations before beginning research, sample strictly within target populations, and state this in their articles [73]. Additionally, researchers should discuss the generalizability of findings, connect research findings to samples, avoid overgeneralization, and clearly state sample limitations [13].

Finally, when conditions permit, researchers should employ more representative sampling methods. For example, probability sampling based on demographic distributions from census data (e.g., [74]); or culture-oriented and theory-driven sampling that tests theories across different cultural contexts based on theoretically relevant dimensions [75]. Notably, although many articles claim to use random sampling, this is rarely strict random sampling in reality—given the enormous target populations and the fact that not every individual is will-

ing to participate, true random sampling is essentially unachievable [76], and researchers should avoid such erroneous descriptions. While most researchers cannot achieve representative sampling in single studies, they can use convenience sampling for theory development and then test theories in populations with other demographic characteristics.

(2) **Academic/Professional Societies**: First, academic societies can establish norms for reporting sample information, encouraging researchers to report detailed demographic information. Second, academic organizations can encourage researchers to focus on populations beyond young college students by holding relevant conferences to help them recognize current sampling limitations and potential solutions. Additionally, workshops on this topic can be organized at academic conferences to share new methods or practices for enhancing representative sampling.

(3) **Journals**: First, international journals need to raise awareness of global diversity by regularly statistics on the global diversity of authors, reviewers, editors, and editorial board members, enabling journals to understand their current global diversity status [65]. Second, journals should appoint researchers from underrepresented countries as editorial board members or even editors-in-chief, as they will facilitate more excellent research from underrepresented countries into publication. In reality, since journals are owned by publishing groups and societies from developed countries, it is difficult for journals to proactively increase editorial board or editor diversity. Developing countries also need to establish high-quality, high-impact international journals based on their own needs, such as *PsyCh Journal* and *Journal of Pacific Rim Psychology*. Additionally, journal editors and reviewers should value research on underrepresented populations, mark it as novel and important, and add diversity badges upon publication [13].

(4) **Funding Agencies**: Funding agencies need to provide more financial support to psychological and brain science researchers to cover the costs of representative sampling. A current reason for using college students as research participants is the lack of experience and funding for sampling other groups. Therefore, funding agencies may need to provide sufficient financial support for research projects requiring more representative or hard-to-research samples. Additionally, funding agencies can encourage researchers to pay more attention to under-studied groups in China and other developing countries, such as rural populations, poor/relatively poor populations, older adults, and minority racial/ethnic populations.

Changing the current situation of psychological and brain science' s excessive focus on young college student populations requires joint efforts from all parties. From the perspective of developmental population neuroscience, studying the richness and complexity of human cognition and brain mechanisms will enhance the generalizability and credibility of research findings, provide valuable knowledge for society, and offer references for building a global community with a shared future.

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Note: Figure translations are in progress. See original paper for figures.