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Prevalence of Transgender Depends on the “Case” Definition: A Systematic Review

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Abstract

Background—We conducted a systematic review and meta-analysis to evaluate how various definitions of “transgender” may affect prevalence estimates.

Methods—PubMed, Embase, and Medline were searched to identify studies reporting prevalence estimates of transgender in a population. All studies were grouped based on the case definition applied to the numerator. Summary estimates were derived using a random-effects model for total prevalence of transgender and for male-to-female (MTF) and female-to-male (FTM) subgroups. Overall and stratum-specific meta-prevalence estimates (mPs) and 95% confidence intervals (CIs) were accompanied by tests for heterogeneity, and meta-regressions to assess sources of heterogeneity.

Results—A total of 32 studies met the inclusion criteria for the systematic review. Of those, 27 studies provided necessary data for a meta-analysis. Overall mP (95% CI) per 100,000 population was 9.2 (4.9, 13.6) for surgical or hormonal gender affirmation therapy and 6.8 (4.6–9.1) for transgender-related diagnoses. Among studies assessing self-reported transgender identity, the mP was 871 (95% 519, 1224); however this result was influenced by a single outlier study. After removal of that study, the mP changed to 355 (95% CI 144, 566). Significant heterogeneity was observed in most analyses.

Conclusions—The empirical literature on the prevalence of transgender highlights the importance of adhering to specific case definitions because the results may range by orders of magnitude. Standardized and routine collection of transgender data is recommended.

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Keywords

transgender; prevalence; cases definition; meta-analysis

INTRODUCTION

In 2011, the Institute of Medicine (IOM) released a landmark report on the health of sexual and gender minority people who are lesbian, gay, bisexual, and transgender (LGBT). The report specifically emphasized the importance of transgender health research to better understand the needs of this underserved population.¹ The Healthy People 2020 initiative underscored the importance of eliminating health disparities affecting LGBT people and of providing accessible and quality care to this population.²

Despite an increasing focus on transgender health research, some of the basic epidemiologic and clinical issues in this area remain unresolved.³ For example, little is known about the prevalence of gender dysphoria or the proportion of the population that should be considered transgender. The reported prevalence estimates are greatly affected by differences in methodology, and by variable definitions of transgender.^{4–7} Several previous reviews have sought to synthesize the available information regarding the size and the demographic characteristics of transgender population;^{8–10} however, these reviews did not systematically assess the impact of study methods on reported prevalence estimates. With these data gaps in mind, the main objectives of the present review were to evaluate the state-of the science on epidemiology of “transgender” and to examine how various definitions of transgender affected prevalence estimates. The secondary objective of this review was to compare findings across studies that used different methodology, in different countries, and over different periods of time.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines¹¹ were followed. Publications reporting transgender prevalence in different population groups were identified via electronic literature databases Medline, EMBASE, and PubMed using multiple combinations of search terms “prevalence”, “gender identity disorder”, “gender dysphoria”, “transgender”, and “transsexual.” The electronic search included all papers published from 1966 through January 2015. To identify reports missed by electronic searches we hand-searched the journals that commonly publish articles addressing transgender health issues, as well as reference lists from relevant studies and reviews.

Study Selection

Two reviewers (LC, MG) independently reviewed each citation. Non-English language articles were translated into English by LC. Each report was assessed according to the following *a priori* eligibility criteria: (1) reported results with prevalence estimates and measures of variance in the general adult population, (2) reported numerator for prevalence estimate, (3) reported identification of denominator or a description of how prevalence

estimate was calculated. Publications that did not report (or did not allow estimating) prevalence in the general population were excluded from the analysis. Some studies were excluded because they reported prevalence of transgender in certain population subgroups such as twins¹² or men-having sex with men,¹³ but not in the general population. Some studies reported frequency of transgender as both prevalence and incidence measures.^{14, 15} In those instances, only prevalence estimates were used because incidence of transgender is difficult to interpret due to a lack of identifiable “date of onset.” To effectively study incidence of transgender in the general population, one needs to systematically collect data on gender identity from large population-based cohorts, preferably recruited at birth. To our knowledge, these data are not available. When two or more studies used the same or overlapping data, only the more recent prevalence estimate was used in the meta-analysis, but all studies were described in the systematic review.

Data Abstraction and Management

The main outcome measure of interest in this review was population prevalence of transgender. Secondary outcomes of interest included gender-specific prevalence estimates for male-to-female (MTF) or female to male (FTM) subgroups.

The two reviewers (LC, MG), abstracted the data from eligible publications. Information was tabulated to allow data management and descriptive analyses. Inconsistencies in the data entry were resolved by consensus. The author of one study¹⁶ was contacted and replied regarding additional information needed for the meta-analysis.

For each publication, data extracted included the size and the case definition of the numerator (e.g., diagnosis of gender dysphoria, or “gender identity disorder,” use of hormonal therapy, or history of gender affirmation surgery), the size and the type of denominator (e.g., general population of a given area, or a total number of participants in a survey), and the overall and gender-specific prevalence estimates. In order to apply meta-analytic techniques, the standard errors for each prevalence estimate were either extracted from the articles or calculated from the available information using OpenEpi on-line statistical software.¹⁷

Data Synthesis

As the language used to describe transgender has evolved considerably in the literature over the last few decades, the original terminology applied to the case definition in each publication was maintained so as not to infer meaning beyond what was stated by the authors.

Eligible publications reporting transgender population prevalence estimates were then grouped into three categories as shown in the **Appendix**. These categories included: 1) studies that reported prevalence of surgical or hormonal gender affirmation therapy; 2) studies that defined numerator based on the diagnosis of “transsexualism,” “gender identity disorder” or “gender dysphoria”; and 3) studies that assessed self-reported gender identity which differed from the assigned sex. All prevalence estimates were standardized and expressed per 100,000 to facilitate comparisons. Studies that used methods inconsistent with

any of the above definitions were examined and discussed separately, but not included in the meta-analysis. Data extracted from publications were analyzed to calculate a pooled summary estimate of transgender prevalence weighted by sample size. Heterogeneity was assessed by a Q-test and its derivative an I^2 measure.¹⁸ The summary statistics were calculated using random effects models and the results were expressed as meta-prevalence (mP) estimates with the corresponding 95% confidence intervals (CI). In addition, subgroup and meta-regression analyses were performed in search for sources of heterogeneity. Variables that were considered as possible sources of heterogeneity included: year the study was conducted, geographic region, and the type of publication (peer-reviewed versus not peer-reviewed). Effect of outliers on the mP estimates was also assessed. All statistical analyses were performed using Stata software package (version 13.0, Stata Corporation, College Station, TX, USA).

RESULTS

Overview of studies

As shown in Figure 1, 1,470 references were screened by title and abstract, and of those 89 publications underwent full-text review. Of the 32 publications included in the final qualitative review, two studies^{19, 20} were based on non-independent data and could not be incorporated in a meta-analysis. Three additional studies^{15, 21, 22} (two of those based on the same data) were not included in a meta-analysis because they used unique case definitions and could not be grouped with other studies. As a result, 27 studies were used in the meta-analysis.

Prevalence of Gender Affirmation Surgery and Hormone Therapy

As shown in Table 1, six publications have estimated prevalence of transgender by considering only those individuals who sought or received gender affirmation surgery, previously known as “sex reassignment surgery” (SRS). Only one of these reports was from the US, four were from Europe, and one from Singapore. The publication dates ranged from 1968 to 2014.

Based on the data from various specialized centers (most notably the Gender Identity Clinic at the Johns Hopkins Hospital), Pauly identified 2,000 MTF and 500 FTM people who requested SRS since 1953.²³ Using the total US population in 1968, the resulting prevalence was estimated at 1/100,000 for MTF and 0.25/100,000 for FTM. Unlike other similar studies, which calculated prevalence of MTF and FTM among natal males and females, respectively, Pauly divided each numerator by the total population.

In 2011, Esteva et al. sent out questionnaires to regions of Spain that have established Gender Identity Units.²⁴ In the questionnaires, the authors inquired about the number of applicants for SRS. Based on responses from all clinics, 3,303 individuals solicited genitoplastic reconstruction or other procedures such as breast augmentation and facial surgeries. Using the total Spanish population between ages 15 and 65 years as the denominator, the prevalence estimate was reported as 10/100,000.

A study in Belgium estimated the proportion of the population that had undergone SRS from 1985 until 2003 through retrospective collection of data on procedures performed by plastic surgeons and gender teams.²⁵ Among the gender teams and plastic surgeons that agreed to participate (response rate 24%), the study identified 412 Belgian-born “transsexuals” (292 MTF and 120 FTM) corresponding to prevalence estimates of 7.74/100,000 and 2.96/100,000, respectively.

Based on the information available from Italian clinics performing SRS procedures, Caldarera and Pfäfflin identified 424 MTF and 125 FTM surgeries performed between 1992 and 2008.²⁶ “SRS” procedures in that study referred to genital surgeries only. Using data from the National Institute of Statistics to estimate the denominator, the authors calculated prevalence of 1.5/100,000 and 0.4/100,000 for MTF and FTM, respectively. The authors acknowledged that their estimates were lower than those reported in other countries and attributed the difference to missing data or cultural factors.

A study in Sweden identified requests for SRS based on the data from the National Board of Health and Welfare Statistics.²⁷ There were 767 applicants for the SRS (478 MTF and 289 FTM); of those 681 were approved and underwent the procedure (429 MTF and 252 FTM). Using the Swedish population as of December 2010, the prevalence estimates for applications for SRS were 12.9/100,000 for MTF and 7.5/100,000 for FTM. The corresponding prevalence estimates limited to those who underwent SRS were 11.6/100,000 for MTF and 6.6/100,000 for FTM.

Only one study assessing prevalence of SRS was conducted outside of North America or Europe. Tsoi calculated prevalence of “transsexualism” by identifying patients in Singapore who had sought SRS and who were subsequently diagnosed as “transsexuals” by psychiatrists.²⁸ The author reported that up until 1986, there were 458 (343 MTF and 115 FTM) Singapore-born “transsexuals” reported by the Department of Obstetrics and Gynecology and by private surgeons. Using the total male and female population of Singapore in 1986, the prevalence was reported as 35.2/100,000 and 12.0/100,000 for MTF and FTM, respectively. The author cites cultural acceptance of “transsexuals” and more established “sex reassignment” surgical procedures as possible reasons for the higher than previously reported prevalence estimates.

Two studies conducted in the Netherlands at the Free Amsterdam University clinic used hormonal therapy among “transsexuals” to define prevalence of transgender (Table 1). In 1976, the clinic established a gender team and based on data collected through 1986, 538 individuals had received hormonal therapy at that facility.¹⁶ Of those, 399 were MTF and 139 were FTM. Using the Dutch Bureau of Statistics data for population estimates, the prevalence was calculated as 5.6/100,000 for MTF and 1.9/100,000 for FTM.

In a more recent study based at the same clinic, the analysis was extended through the end of 1990.²⁹ By that time, the clinic was providing hormonal therapy to 713 Netherlands-born “transsexual” patients over the age of 15 years; 507 MTF and 206 FTM. The total population of the Netherlands from 1990 was used to calculate the prevalence estimates of 8.4/100,000 for MTF and 3.3/100,000 for FTM.

Prevalence of transgender-related diagnoses

Ten studies calculated prevalence of documented transgender-related diagnoses using International Classification of Disease (ICD) or the Diagnostic and Statistical Manual of Mental Disorders (DSM), but application of codes varied across the studies (Table 2). The terminology of transgender-related conditions and the diagnostic criteria have also evolved over the years.³⁰

Hoenig & Kenna aimed to identify all patients diagnosed as “transsexual” at the University Department of Psychiatry at the Royal Infirmary, Manchester between 1958 and 1968.³⁰ The study relied on referral of patients from other clinics. The clinic identified 66 individuals. Using the population of the Manchester Region on June 30, 1970, the prevalence estimates were calculated as 1.9/100,000 overall, 2.8/100,000 for MTF, and 0.9/100,000 for FTM.

In a study based in Northern Ireland, O’Gorman collected information from the Department of Mental Health, Queen’s University, Belfast.³¹ Twenty-eight individuals diagnosed as “transsexual” were identified (21 MTF and 7 FTM) over an unspecified fourteen year period. Using an approximation of the population in Northern Ireland, the overall prevalence was estimated at 1.9/100,000.

Esteva et al. estimated the prevalence of “gender identity disorder” based on clinic data from the Gender Identity Disorder Unit in Andalucía, Spain.³² The clinic reported that from its opening in 1999 until October 2004, they had seen a total of 391 individuals with this diagnosis, 243 MTF and 148 FTM. Using the total population of Andalucía in 2004, the corresponding prevalence estimates were reported as 10.3/100,000 for MTF and 6.5/100,000 for FTM.

In another Spanish study, Gomez Gil et al. estimated the prevalence of “transsexualism” in Catalonia using ICD-10 diagnostic code of F64.0 documented at the Hospital Clinic in Barcelona from 1996 through 2004.³³ The authors identified 161 patients (113 MTF and 48 FTM) who were living in Catalonia and based on population data from the regional Institute of Statistics, the prevalence estimates for MTF and FTM were calculated as 4.8/100,000 and 2.1/100,000, respectively. The authors also calculated the Barcelona-specific prevalence of 5.5/100,000 for MTF and 2.5/100,000 for FTM indicating a higher proportion of transgender people in the urban population.

In Japan, the prevalence of “gender identity disorder” was determined from the outpatient clinic of Okayama University hospital between April 1997 and October 2005.³⁴ Using the DSM-IV criteria, 579 patients (230 MTF and 349 FTM) constituted the numerator. The prevalence estimate for FTM was reported as 0.9/100,000.

Another Japanese study sought to assess the prevalence of “gender identity disorder” based on data collected at the specialized clinic of the Sapporo Medical University Hospital between December 2003 and January 2010.³⁵ Identification of cases was based on diagnoses using ICD-10 and DSM-IV codes. The study identified 343 patients (104 MTF and 238 FTM). Using the population of Hokkaido as the denominator, the MTF and FTM prevalence estimates were 3.97/100,000 and 8.20/100,000 respectively. The authors conclude that FTM

may represent a greater proportion of transgender people in Japan than in other parts of the world, which is in agreement with the previous report from that country.³⁴

Ahmadzad-Asl et al. aimed to estimate the prevalence of “gender identity disorder” in Iran between 2002 and 2009 through review of records at the Tehran Psychiatric Institute and identification of subjects with a diagnosis of gender identity disorder according to the DSM-IV criteria.³⁶ A total of 281 individuals (138 MTF and 143 FTM) were identified yielding prevalence estimates of 0.7/100,000 total, 0.69/100,000 for MTF and 0.74/100,000 for FTM. The authors postulate that the patriarchal socio-cultural characteristics in Iran may explain the roughly equal numbers of MTF and FTM.

Using the DSM-IV and DSM-V criteria, Judge and colleagues collected information on patients diagnosed with “gender dysphoria” at the Department of Endocrinology of St. Columille’s Hospital in Dublin between 2005 and 2014.³⁷ Among 218 patients referred to the clinic, 159 were MTF and 59 were FTM. Based on the 2011 census data, the prevalence estimates were reported as 6.8/100,000 total, 9.88/100,000 for MTF and 3.6/100,000 for FTM.

In a recent study conducted in the United States, Blosnich et al. used the Veterans Health Administration (VHA) electronic medical records from 2000 through 2011 to examine the prevalence of transgender-related diagnoses among veterans.²⁰ The numerator for the study included individuals who received ICD-9 diagnostic codes of 302.85 or 302.6 to define “gender identity disorder”. Using the VHA electronic record database to define the denominator for each year, the 2002 prevalence estimate was 12.5/100,000 and the prevalence reported in 2011 was 22.9/100,000, indicating an almost two-fold increase over the ten-year study period. Although these data did not distinguish MTF from FTM, it is important to note that the VHA population is 95% natal males.

In a more recent VHA-based publication, Kauth et al. used ICD-9 codes 302.85, 302.6, and 302.5 (transsexualism) identified between 2006 and 2013.³⁸ Prevalence in 2013 was reported as 32.9/100,000 (95% CI: 21.6, 44.1). This result is not directly comparable to those reported in the Blosnich et al. study due to expanded criteria for the case definition. In addition, the denominator in the Kauth et al study included all VHA enrollees while Blosnich et al. calculated the prevalence among VHA care utilizers.

Table 2 also includes three studies (from Sweden, Australia, and Scotland), which calculated the prevalence of transgender-related diagnoses by surveying clinics specializing in treatment of transgender patients. All three studies present relatively old data with publication dates between 1968 and 1999.

Walinder estimated the prevalence of “transsexuals” in Sweden in 1968 through a survey of psychiatric clinics.³⁹ Seventy-six percent of the psychiatrists reported providing treatment to a total of 67 “transsexuals”. After including 43 additional individuals known to the author, the numerator used for calculations was 110. Using census data from Sweden, the prevalence estimates were calculated as 1.9/100,000 total; 2.7/100,000 for MTF and 1/100,000 for FTM.

Prevalence of “transsexuals” in Australia between June 1976 and June 1978 was estimated through distribution of questionnaires to subscribers of the Australian and New Zealand Journal of Psychiatry.⁴⁰ According to the authors, all psychiatrists in Australia receive this journal. Of 904 questionnaires distributed, 263 were returned (29.1%). Based on the completed questionnaires, 243 “transsexual” individuals (209 MTF and 34 FTM) were identified. Prevalence estimates were calculated using the population of Australia 15 years of age or older as of June 31, 1978; and were determined to be 2.4/100,000 total, 4.2/100,000 for MTF and 0.7/100,000 for FTM.

Wilson et al. surveyed general medical practices in Scotland in 1998.⁴¹ The questionnaire obtained information regarding the number of patients registered to the practice as well as the number of patients with “gender dysphoria.” Just under three-quarters (73%) of the surveys were completed and returned, identifying 273 eligible patients. The denominator for calculation of the prevalence was based on the number of patients over the age of 15 years registered to the respondent’s practices standardized to match the age distribution of the general population in Scotland. The resulting population prevalence of gender dysphoria was 8.2/100,000.

Two studies (one in Iceland and one in Taiwan) ascertained prevalence of “transsexualism” using diagnostic interviews of the general population.^{42, 43} Both studies reported prevalence estimates that far exceeded those obtained from clinics or from surveys of health care providers (Table 2)

Prevalence of Transgender Identity

Six studies utilized survey-based data to estimate prevalence of gender identity that differed from the binary sex categories assigned at birth (Table 3). Three of these studies were based in the United States, one in the Netherlands, one in Belgium, and one in Taiwan.

Conron et al. analyzed data collected between 2007 and 2009 from the Massachusetts Behavioral Risk Factor Surveillance Study (MA-BRFSS).⁴⁴ The survey was administered to 28,662 adults ages 18 to 64 years. Each participant was asked: “*Some people describe themselves as transgender when they experience a different gender identity from their sex at birth. For example, a person born into a male body, but who feels female or lives as a woman. Do you consider yourself to be transgender?*” There were 131 participants who responded ‘yes’ to that question, corresponding to a prevalence of 500/100,000 persons. The authors acknowledge that their estimate may have been affected by misclassification bias due to the broad scope of the question. Another limitation of the data is a lack of information on natal sex and gender identity.

Gates combined reports from the 2003 California LGBT Tobacco Survey, and the 2009 California Health Interview survey in order to estimate the number transgender adults in the general population.^{16, 44} The 2009 California Health Interview Survey reported that 3.2% of adult participants were LGBT. Based on the 2003 California LGBT Tobacco Survey, 2.4% of LGBT persons self-identify as transgender. Using these considerations Gates further estimated that the prevalence of transgender people among California adults is 0.1% or 100 per 100,000.

A 2010 survey used the Growing Up Today (GUTS) prospective cohort study of US young adults.⁴⁵ The survey implemented a two-step approach by first inquiring about sex assigned at birth, and then asking the participants about their self-described gender identity with the response options “Female,” “Male,” “Transgender,” or “Do not identify as female, male or transgender.” Among the 7,831 survey respondents, 26 (0.33%) identified as having gender identity that was different from their assigned (natal) sex. Of those, 7 (0.09%) were cross-sex identified, 5 (0.06%) self-described as transgender, and 14 (0.18%) did not identify as female, male, or transgender.

Using a 2012 internet-based sexual health survey of persons 15 to 70 years of age, Kuyper and Wijzen estimated the proportion of transgender people in the Netherlands.⁴⁶ The study aimed to identify individuals with “incongruent gender identities” and “gender dysphoric feelings.” The final sample included 8,064 participants, who were asked questions regarding gender identity and gender dysphoric feelings and the responses were recorded on a Likert Scale. About 20% of those invited to participate completed the questionnaire and met the eligibility criteria. Although the exact case definition is not clear, among natal males the reported prevalence was 600/100,000 and among natal females the corresponding estimate was 200/100,000.

Van Caenegem et al. estimated prevalence of “gender nonconformity” based on a population survey of adolescent and adult (age range 14–80 years) residents of the Flanders region, Belgium.⁴⁷ Survey participants were randomly selected from the Belgian National Register. Forty percent of eligible persons completed the survey. The denominator for prevalence calculations included 1,799 participants (864 natal males and 905 natal females). Questions pertaining to gender identity were assessed via a computer assisted personal interview. Based on a 5-point Likert scale (ranging from 1-totally disagree to 5-totally agree) the participants were asked to score statements “*I feel like a woman*” and “*I feel like a man*.” A person was considered “gender ambivalent” if the same answer (e.g., a score of 1 or a score of 2) was given to both statements. “Gender incongruence” was defined as a lower score assigned to the natal sex than to the opposite sex. Using these definitions, the prevalence for “gender incongruence” was estimated to be 700/100,000 natal males and 600/100,000 natal females. The corresponding estimates for “gender ambivalence” among natal males and females were 2,200/100,000 and 1,900/100,000, respectively.

A 2009 study of Taiwanese university students conducted interviews with 5,010 participants using the Adult Self-Report Inventory-4, which is a DSM-IV referenced scale.⁴⁸ Self-reported “gender dysphoria” was determined based on a response to the statement “I wish I was the opposite sex.” Responses “often” and “very often” were interpreted as evidence of gender dysphoria. The use of this rather loose definition of gender dysphoria resulted in very high prevalence estimates of 7,300/100,000 for FTM and 1,900/100,000 for MTF.

Prevalence of legal name or sex changes

Two studies, one from Germany and another from New Zealand, reported population prevalence of transgender based on documented administrative sex or name change.

Weitze and Osburg relied on the 1981 German Transsexuals' Act, which allowed applicants to change their first name or their legal sex status. The study examined the decisions rendered during the first 10 years since implementation of the law.¹⁵ Information regarding the number of relevant applications and corresponding decisions was collected from the courts. During the study period, the courts issued decrees on 683 first name changes and 733 rulings on legal reestablishment of sex. These rulings concerned 1,199 individuals of which 1,047 received the approval. Using the adult population of West Germany before reunification, the prevalence was estimated as 2.1/100,000. A more recent report extended the work of Weitze and Osburg by evaluating change in legal sex status between 1991 and 2000 in all of Germany.²² The overall "transsexual" prevalence was estimated as 3.88/100,000 using the German population in 2000 as the denominator. The MTF and FTM prevalence estimates were 4.95/100,000 and 2.87/100,000, respectively.

In New Zealand, individuals may request a change of their gender code from 'M' or 'F' to 'X'. To examine the frequency of this change, Veale contacted the New Zealand Department of Internal Affairs Passport Office.²¹ A total of 385 such changes were identified in 2008, and given the number of passport holders in New Zealand the prevalence was calculated as 16/100,000. Considering that 49% of passport holders in New Zealand were male and 51% were female, the corresponding prevalence estimates were 27/100,000 for MTF and 4.4/100,000 for FTM with a sex ratio of 6:1.

Meta-Analysis

Among studies reporting estimates for individuals who sought or received gender affirmation therapy, the summary analysis revealed a total mP of 9.2/100,000 (95% CI: 4.9, 13.6) with a range between 0.9 and 35.0 (Table 4). The studies of surgical gender affirmation were further sub-categorized based on whether SRS was received or requested with mP (95% CI) estimates of 5.5 (0.5, 10.5) and 9.2 (5.2, 13.3) per 100,000, respectively. Significant heterogeneity was present in all of the analyses ($I^2 > 99\%$). Meta regression demonstrated no significant time trend (regression coefficient = -0.33, p-value = 0.28).

A meta-analysis of studies that assessed prevalence of transgender-related diagnoses produced an overall mP estimate of 6.8/100,000 (95% CI: 4.6, 9.1); 5.8/100,000 (95% CI: 3.5, 8.1) for MTF and 2.5/100,000 (95% CI: 1.9, 3.1) for FTM (Table 5). Meta-regression demonstrated that study location, categorized as Europe, Asia, or Other (including US) was a predictor of prevalence (regression coefficient = 3.11, p-value < 0.01). By contrast there was no association with year of publication (regression coefficient = -0.25, p-value = 0.18).

As shown in Table 6, among studies that examined prevalence of transgender identity, the summary estimates were much higher than in the previous two groups. Although the results appeared heterogeneous in the overall analysis, the heterogeneity was primarily driven by one outlier study.⁴⁸ After this outlier study was removed from the analyses, the results for MTF and FTM were highly homogenous ($I^2 < 1\%$).

DISCUSSION

Meta-analysis was proposed and is still often used as a way of integrating findings from multiple studies.⁴⁹ While a meta-analytic techniques allow calculating a summary estimate for a particular measure, the correct interpretation of this summary estimate may be difficult and sometimes impossible due to disagreement across results, differences in study methods or low quality of the available data.⁵⁰ When a summary measure of association does not allow meaningful conclusions, meta-analysis may still provide important information about patterns of results and their relation to study characteristics.⁵¹ With these considerations in mind, the current communication should not be viewed as an attempt to obtain an average measure of transgender prevalence. Rather our analyses aimed to explore patterns of the reported estimates, and to perform an assessment of the extent and sources of agreement and disagreement across studies.

The specific focus on case definitions and other study characteristics is perhaps the main difference between our meta-analysis and similar recently published meta-analysis by Arcelus and colleagues.¹⁰ Another methodological feature that distinguishes our meta-analysis from the meta-analysis by Arcelus et al. is inclusion of studies assessing self-reported transgender status.

Whereas in most studies estimating the prevalence of surgical or hormonal gender affirmation therapy or transgender-related diagnoses, the prevalence estimates generally ranged between 1 and 30 per 100,000 individuals, self-reported transgender identity was orders of magnitude higher ranging from 100 to 700 per 100,000 or 0.1%-0.7%. For reference, 1% is the approximate proportion of American Indians and Alaska Natives in the population of the United States,⁵² and 0.1% (100/100,000) is the percentage of the US residents over the age of 5 years who speak Greek at home.⁵³ One study reported an even higher prevalence of almost 5%,⁴⁸ but there is a good reason to suspect that reliance on a single survey item ("I wish I was the opposite sex") may have resulted in an inflated estimate.

The analyses for both the treatment- and the diagnosis-based studies demonstrated significant statistical heterogeneity, and for this reason the overall mP in these two categories of studies are not particularly informative. The heterogeneity of results (even after exclusion of outliers) may be explained by three factors: 1) inclusion of worldwide populations with different cultural and legal contexts; 2) wide range of time periods covered in different studies and 3) the very low variance of the prevalence estimates attributable to the fact that the denominator in many calculations was the assumed total population of the study area rather than a sample of that population. The significant heterogeneity may explain some of the counterintuitive results including the slightly higher mP estimate for treatment request or receipt vs. diagnosis and the lack of clear time trend in the meta-regression. Notably, the within-study comparisons consistently show that transgender prevalence is indeed increasing over time.^{19, 20, 38}

Unlike treatment- and the diagnosis-based results, the meta-analysis of self-reported transgender identity revealed less heterogeneity, particularly in the MTF- and FTM-specific analyses after exclusion of one obvious outlier.⁴⁸

With respect to methodological issues, a particular shortcoming of the extant literature, and of this meta-analysis, is the lack of good denominator data. Prevalence by definition is a proportion; that is, a ratio in which all observations in the numerator arise from a pre-defined denominator.⁵⁴ The majority of studies included in this review first quantified the numerator and then used an approximated population size to arrive at a prevalence estimate. With these limitations in mind, future research should employ established formal methods of prevalence calculations, such as those used in the recent studies of US veterans.^{20,38}

To summarize, the current literature on prevalence of transgender identity highlights the importance of adhering to specific case definitions because the results may range several hundred-fold depending on how the numerator was ascertained. A more definitive weight-of-evidence assessment will be possible when studies conducted in different population groups use the same or similar methodology. Standardized and routine collection of transgender data at a population level is recommended.

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Appendix: Categorization of “case” definitions of transgender

Case definition categories	Authors case definition
Gender affirmation therapy	Receipt of sex reassignment surgery ^{25, 26, 27} Request for surgical procedure ^{23, 24, 27, 28} Hormonal therapy receipt ^{19, 29}
Transgender related diagnoses	DSM-IV, gender identity disorder ^{34, 35, 36, 37} DSM-V, gender dysphoria ³⁷ ICD-9, gender identity disorder, gender dysphoria, transsexualism ^{20, 38} ICD-10, Transsexualism ^{33, 35} gender identity disorder ³² gender dysphoria diagnosis ⁴¹ “Transsexual” diagnosis ^{14, 31, 39, 40, 43} Diagnostic Interview Survey ⁴² Transgender identity Transgender identity, self-reported ^{16, 44, 45} Gender nonconformity ⁴⁷ Self-reported gender dysphoria ^{46, 48}

Figure 1.
Flow chart of the literature search and retrieval for publications reporting transgender population prevalence estimates

Prevalence of receipt or requests to receive gender affirmation surgery or hormonal therapy

Table 1

Reference	Location; time period	Case definition	Source of numerator	Numerator			Source and size of denominator	Prevalence (per 100,000)			Ratio MTF:FTM
				Total	MTF	FTM		Overall	MTF	FTM	
Bakker, A et al. 1993 ²⁹	Netherlands, 1976–1990	Receipt of HT	Free University of Amsterdam (AZVU) clinic records	713	507	206	Center of Statistics: 6,019,546 males and 6,252,566 females		8.4	3.3	2.5:1
Caldarera and Pfäfflin, 2011 ²⁶	Italy, 1992–2008	SRS receipt	Surgical Clinics	549	424	125	National Institute of Statistics 2009: Total 59,619,290 (28,949,747 males and 30,669,543 females)	0.9	1.5	0.4	3.39:1
De Cuypere et al. 2007 ²⁵	Belgium, 1985–2003	SRS receipt	Questionnaires sent to “gender teams” and plastic surgeons	412	292	120	January 2003 population: 3,758,969 males and 4,048,095 females		7.7	3.0	2.43:1
Dhejne et al. 2014 ²⁷	Sweden, 1960–2010	Request (and receipt) of SRS	National Board of Health and Welfare Statistics	767 (681)	478 (429)	289 (252)	December 2010 population: 3,704,685 males and 3,791,791 females	10.2 (9.1)	12.9 (11.6)	7.5 (6.6)	1.7:1
Eklund, PLE et al. 1988 ¹⁹	Netherlands, 1976–1986	Receipt of HT	Free University of Amsterdam (AZVU) clinic records	538	399	159	Dutch Census Data: 7,125,000 males and 8,368,421 females *		1980: 2.2 1983: 3.8 1986: 5.6	1980: 0.5 1983: 1.0 1986: 1.9	3:1
Esteva et al. 2012 ²⁴	Spain, 1999–2011	Request for SRS	Questionnaires sent to Gender Identity Units	3303			Spanish population 15–64 years old, 33,030,000 *	10.0			1.9:1
Pauly 1968 ²³	US, Dates not specified	Request of SRS	Author's communication with specialized centers		2000	500	200,000,000 total US population		1.0	0.25	4:1

Reference	Location; time period	Case definition	Source of numerator	Numerator			Source and size of denominator	Prevalence (per 100,000)			Ratio MTF:FTM
				Total	MTF	FTM		Overall	MTF	FTM	
Tsoi 1988 ²⁸	Singapore, until 1986	Request of SRS	Documented diagnosis of transsexualism as part of pre-SRS evaluation	458	343	115	used for both MTF and FTM calculations ^{**}		35.0	12.0	3:1

* Denominator calculated from the numerator from the reported prevalence

** Prevalence calculated using total population as the denominator

SRS= Sex Reassignment Surgery (now commonly referred to as gender affirmation surgery)

HT = Hormone Therapy

Table 2

Prevalence of transgender-specific diagnoses

Reference	Location; time period	Case definition	Source of numerator	Numerator			Source and size of denominator	Prevalence (per 100,000)			Ratio MTF:FTM
				Total	MTF	FTM		Overall	MTF	FTM	
Ahmadzad-Asl, et al. 2011 ³⁶	Iran, 2002–2009	GID diagnosis DSM-IV-TR	Tehran Psychiatric Institute	281	138	143	Center of Statistics of Iran, population aged 15–44 39,526,948	0.7	0.69	0.74	0.96:1
Baba et al. 2010 ³⁵	Hokkaido, Japan, Dec 2003–Jan 2010	GID diagnosis ICD-10 and DSM-IV	Sapporo Medical University Hospital	342	104	238	Native Japanese Hokkaido Residents 5,500,000		3.97	8.2	1:2
Blosnich, et al. 2013 ²⁰	VA system, US, 2002–2011	ICD-9 codes 302.85 (GID) or 302.6 (GID NOS)	Affirmed GID diagnosis in VHA, FY 2000–2011	2002: 569 2011: 1329			Total VHA patients 4,544,353 (2002), 5,795,165 (2011)	2002: 12.5 2011: 22.9			
Esteva et al. 2006 ³²	Andalucía, Spain, 1999–2004	GID diagnosis	Regional Gender Identity Disorder Unit		243	148	Regional Population: 2,359,223 males and 2,276,923 females [*]		10.3	6.5	1.64:1
Gomez-Gil et al. 2006 ³³	Catalonia, Spain, 1996–2004	ICD- 10 F64.0 (transsexualism)	Psychiatric and Psychology Institute at the Barcelona Hospital, 1996–2004		Catalonia: 113 Barcelona:100	Catalonia: 48 Barcelona:45	Catalonia: 2,376,538 males 2,308,611 females Barcelona: 1,996,708 males 1,776,269 females)		Catalonia: 4.8 Barcelona: 5.5	Catalonia: 2.1 Barcelona: 2.5	2.6:1
Hoening and Kenna, 1974 ¹⁴	England and Wales, 1958–1968	“transsexual” diagnosis	Royal Infirmary Manchester at the University Department of Psychiatry,	66	49	17	Manchester population June 30th 1970: 3,498,700 (1,652,000 males 1,846,700 females)	1.9	2.9	0.9	3.25:1
Hwu et al. 1989 ⁴²	Taiwan 1982–1986	Diagnostic Interview Survey	Multistage random sampling method	3-Taipei 6- small towns 3-rural villages			5,000-Taipei 3,000-Small towns 3,000-Rural villages	60-Taipei 200-Small towns 30-Rural villages	40-Taipei 0-Small towns 0-Rural villages	80-Taipei 420-Small towns 70-Rural Vilages	1:2 Taipei
Judge et al. 2014 ³⁷	Ireland, 2005–2014	DSM-IV GID DSM- V GD	GD Clinic Referrals 2005–2014	218			2011 Census Reports: total 3,205,882 [*]	6.8	9.88	3.6	2.7:1
Kauth et al. 2014 ³⁸	VA system, US, 2006–2013	ICD-9 codes 302.85 (GID), 302.6 (GID NOS), 302.5 (transsexualism)	Affirmed GID diagnosis VHA, FY 2006–2013	2567			VHA Enrollees 7,809,269	32.9			
O’Gorman et al. 1982 ³¹	Northern Ireland, dates not specified	“transsexual” diagnosis	Clinic based, over 14 years	28	21	7	Northern Ireland Population 1,500,000	1.9			3:1
Okabe et al. 2008 ³⁴	Japan, April 1997– October 2005	DSM-IV, GID	GID Clinic- Okayama University Hospital	579	349	230	Inhabitants of Western Japan, Estimated at 40,000,000 ^{**}		0.9		1.5:1

Reference	Location; time period	Case definition	Source of numerator	Numerator			Source and size of denominator	Prevalence (per 100,000)			Ratio MTF:FTM
				Total	MTF	FTM		Overall	MTF	FTM	
Ross, MW et al. 1981 ⁴⁰	Australia, 1976–1978	“Transsexual” diagnosis	Questionnaires to registered psychiatrists	243	209	34	Australia’s population on June 31, 1978 10,616,188 *	2.4	4.2	0.7	6.1:1
Stefansson et al, 1994 ⁴³	Iceland, 1931–1986	“Transsexual” Diagnosis	Diagnostic Interview Schedule	1			862 persons representing half of the 1931 birth cohort in Iceland (441 males, 421 females)	100			
Walinder, et al. 1968 ³⁹	Sweden, as of 1965	“Transsexual” diagnosis	Survey of psychiatrists	110			Not stated 6,272,886 *	1.9	2.7	1.0	2.5:1
Wilson, et al. 1999 ⁴¹	Scotland, 1998	GD	Questionnaires to general medical practices	273	218	55	Registered patients over 15 years of age 3,336,261 (1622,090 males 1,714, 171 females)	8.2	13.4	3.2	4:1

* Denominator calculated from the numerator from the reported prevalence

** Prevalence calculated using total population as the denominator

GD = Gender Identity Disorder; GD = Gender Dysphoria. ICD = International Classification of Diseases, DSM = Diagnostic and Statistical Manual of Mental Disorders.

Table 3

Prevalence of self-reported transgender identity

Reference	Location; time period	Case definition	Source of numerator	Numerator			Source and size of denominator	Prevalence (per 100,000)			Ratio	
				Total	MTF	FTM		Overall	MTF	FTM	MTF:FTM	
Conron, et al. 2011 ⁴⁴	Massachusetts, US, 2007–2009	Self-identity as transgender	Massachusetts Behavioral Risk Factor Surveillance Survey 2007–2009	131			28,176 survey participants	500				
Kuyper and Wijsen, 2014 ⁴⁶	Netherlands, 2013	Self-reported gender dysphoria	Sexual Health Survey		48	16	8,064 survey participants (3,927 males, 4,137 females)		600	200	3:1	
Gates, 2011 ¹⁶	California, US, 2003–2009	Self-identity as transgender	2009 California Health Interview Survey, 2003 CA LGBT Tobacco Survey	49			47,614 survey participants in the California Health Interview Survey	100				
Lai et al. 2010 ⁴⁸	Taiwan, University 2003–2004	Self-reported gender dysphoria	Adult Self-Report Inventory-4, DSM-IV referenced rating	225	49	176	5010 (2585 males, 2425 females) first year college students	4500	1900	7300	1:3	
Reisner, 2014 ⁴⁵	US, 2010	Self-Identity as transgender	Growing Up Today Study (GUTS)	26	10	16	7,831 (2,605 males, and 5,226 females) study participants	330	380	310		
Van Caenegem, et al. 2015 ⁴⁷	Flanders, Belgium, 2011–2012	“Gender nonconformity”	Sexual Health Survey	13	7	6	1,799 survey participants (894 males, 905 females)	722	671	552	1.2:1	

Table 4

Meta-analysis of prevalence estimates for receipt or requests to receive gender affirmation therapy

Analysis type	Estimate per 100,000	95% CI	I-Square	P for Heterogeneity
All studies				
Total	9.2	(4.9, 13.6)	99.9%	<0.01
MTF	12.5	(7.0, 17.9)	99.0%	<0.01
FTM	5.1	(2.6, 7.6)	99.0%	<0.01
SRS receipt				
Total	5.5	(0.5, 10.5)	99.8%	<0.01
MTF	7.6	(0.8, 14.3)	99.7%	<0.01
FTM	3.7	(0.4, 7.1)	99.5%	<0.01
SRS request				
Total	9.2	(5.15, 13.3)	99.3%	<0.01
MTF	13.5	(6.2, 20.8)	99.7%	<0.01
FTM	5.3	(2.0, 8.6)	99.3%	<0.01

Table 5

Meta-analysis prevalence estimates of transgender-specific diagnoses

Analysis type	Estimate per 100,000	95% CI	I-Square	P for Heterogeneity
All studies				
Total	6.8	(4.6, 9.1)	99.6%	<0.01
MTF	5.8	(3.5, 8.1)	98.8%	<0.01
FTM	2.5	(1.9, 3.1)	96.7%	<0.01
Excluding population surveys				
Total	6.7	(4.5, 9.0)	99.7%	<0.01
MTF	5.8	(3.5, 8.1)	99.0%	<0.01
FTM	2.5	(1.9, 3.1)	97.7%	<0.01

Table 6

Meta-analysis prevalence estimates of transgender identity

All Studies	Estimate per 100,000	95% CI	I-Square	P for Heterogeneity
Total	871.2	(518.9, 1223.5)	98.2%	<0.01
MTF	846.2	(316.5, 1375.9)	86.0%	<0.01
FTM	1557.5	(672.5, 2442.4)	97.0%	<0.01
Excluding Lai et al 2010				
Total	355.1	(143.8, 566.4)	95.1%	<0.01
MTF	521.5	(335.9, 707.0)	0%	0.51
FTM	256.2	(138.7, 373.7)	0%	0.47