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Differences in All-Cause Mortality Among Transgender and Non-Transgender People Enrolled in Private Insurance

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ABSTRACT Few studies have analyzed mortality rates among transgender (trans) populations in the United States and compared them to the rates of non-trans populations. Using private insurance data from 2011 to 2019, we estimated age-specific all-cause mortality rates among a subset of trans people enrolled in private insurance and compared them to a 10% randomly selected non-trans cohort. Overall, we found that trans people were nearly twice as likely to die over the period as their non-trans counterparts. When stratifying by gender, we found key disparities within trans populations, with people on the trans feminine to nonbinary spectrum being at the greatest risk of mortality compared to non-trans males and females. While we found that people on the trans masculine to nonbinary spectrum were at a similar risk of overall mortality compared to non-trans females, their overall mortality rate was statistically smaller than that of non-trans males. These findings provide evidence that some trans and non-trans populations experience substantially different mortality conditions across the life course and necessitate further study.

KEYWORDS Mortality • Transgender • Disparity • Life expectancy • Gender

Introduction

A substantial body of public health literature has investigated the relationship between gender and mortality (Case and Paxson 2005; Rogers et al. 2010; Ross et al. 2012). However, few studies have analyzed the risk of mortality among transgender and nonbinary (trans) populations. Among studies that include trans people, a majority have been conducted in Europe and have found that trans people are at higher risk of mortality than their non-trans counterparts (Asscheman et al. 2011; Dhejne et al. 2011; Simonsen et al. 2016; Van Kesteren et al. 1997; Wiepjes et al. 2020). In the United States, two studies have been conducted to understand population-level mortality risk among a select sample of trans people who accessed care through the Veteran Healthcare Administration (Blosnich et al. 2014; Boyer et al. 2021), while

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one other simply reported the crude death rate among trans individuals enrolled in commercial insurance in Georgia and California (Quinn et al. 2017).

Disparities in Morbidity, Suicidality, and Violence in Trans Communities

Despite the absence of studies on mortality in trans populations in the United States, research on morbidity has documented notable disparities in infectious and noncommunicable diseases that may result in premature death between trans and non-trans populations and within trans populations. For example, when compared to their non-trans counterparts, trans people have a higher prevalence of HIV, cardiovascular disease, and diabetes (Downing and Przedworski 2018; Dragon et al. 2017; James et al. 2016; Meyer et al. 2017). Within trans populations, the prevalence of certain chronic and acute conditions varies by gender identity. For example, researchers have found that trans women and nonbinary individuals are at a greater risk of diabetes, coronary heart disease, and myocardial infarction than are trans men (Downing and Przedworski 2018; Jasuja et al. 2020).

Furthermore, research finds that trans populations have elevated rates of mental and behavioral health conditions that may lead to early mortality, including depression, substance use disorders, and suicidal ideation (Blosnich et al. 2013; Blosnich et al. 2014; Downing and Przedworski 2018; Dragon et al. 2017; Hughto et al. 2021; James et al. 2016; Marshall et al. 2016; Rabasco and Andover 2020). Among trans populations, prevalence estimates for attempted suicide range from 10% to 44%, much higher than the estimated 4.6% among the general U.S. population (Haas et al. 2014; Marshall et al. 2016). Furthermore, the prevalence of suicidal ideation among trans populations ranges from 37% to 83% across studies (Marshall et al. 2016). In comparative studies, trans people have shown much greater rates of suicidal ideation than their non-trans peers (Mathy 2003). Some studies report that the risk of suicide attempt and suicidal ideation varies within trans populations by gender identity, while others have found similar rates within subpopulations (Haas et al. 2014; Herman et al. 2019; Marshall et al. 2016; Surace et al. 2020).

Studies with community and online samples suggest that trans people also experience higher rates of interpersonal violence, discrimination, and other forms of enacted stigma than does the general population (White Hughto et al. 2015; Wirtz et al. 2020). In particular, trans people experience higher rates of serious violence, assault, and violence-induced injury than do non-trans populations (Flores et al. 2020; Grant et al. 2011; James et al. 2016; Stotzer 2009; Truman et al. 2019). These experiences can directly result in death or indirectly lead to premature death by exacerbating physical and mental health conditions. Moreover, between 2008 and September 2020, nearly 300 trans people were murdered in the United States, and this number is likely grossly underestimated because gender identity is not routinely reported in violent crime statistics (Balzer 2020; Haas et al. 2019). Although it is not yet established whether variations in the incidence of all forms of violence exist within trans populations (Wirtz et al. 2020), the vast majority of trans homicide victims are trans women of color (Dinno 2017).

Empirical research finds that trans populations in the United States are often at greater risk of morbid conditions than the general public, and these disparities are

theorized to be fundamentally caused by anti-trans stigma (Hatzenbuehler et al. 2013; Transgender Law Center n.d.; White Hughto et al. 2015). Indeed, the nation's dominant gender ideology normalizes and reifies the man/woman binary, stigmatizing those whose gender does not align with the identity or expression typically associated with their sex assigned at birth (Hatzenbuehler and Pachankis 2016; West and Zimmerman 1987; White Hughto et al. 2015). Anti-trans stigma promotes widespread discrimination and stereotyping of trans people, which reduces trans people's access to critical resources needed to promote health and well-being (e.g., health care, housing, employment), increases risk of interpersonal violence, and causes excess stress and hypervigilance within trans individuals (Hendricks and Testa 2012; White Hughto et al. 2015).

Given the co-occurrence of disproportionately high rates of morbidity, suicidality, and violence among trans populations, investigating whether there are also differences in mortality between trans and non-trans people in the United States is essential. This work may support future research seeking to understand and document the root causes of disparities among trans people and set a policy agenda to understand and address the material and social mechanisms that might contribute to such disparities.

Efforts to Link Gender Identity Information With Mortality Data

Shortcomings regarding the uniform and accurate collection of gender identity in mortality data have impeded research on mortality among U.S. trans populations (Haas et al. 2019). For example, the U.S. Standard Certificate of Death, the most basic source of information about mortality, has not routinely included or adequately captured gender identity information (Haas et al. 2019). Currently, three states allow for amending the sex indicators on state death certificates on the basis of primary informants, legal documents, or medical records; however, it is unclear whether data are collected in a way that allows researchers to identify trans people (Haas et al. 2019). Considering these deficiencies, Haas et al. (2019) have advocated for the collection of gender identity information in other mortality surveillance systems such as the National Violent Death Reporting System, but collection of gender identity in mortality data remains limited.[1]

Given the inadequacies of standard mortality data, analysis of administrative data (e.g., insurance claims) has the potential to estimate the risk of mortality in trans populations. The development of algorithms to identify trans individuals in these data sets (Ewald et al. 2019; Jasuja et al. 2020; McDowell et al. 2019; Progovac et al. 2018) allows for the study of diverse health outcomes among trans populations and comparison to their non-trans peers. However, only three studies have utilized administrative claims data to analyze mortality in trans populations in the United States (Blosnich et al. 2014; Boyer et al. 2021; Quinn et al. 2017). Using Veterans Health Administration data, Blosnich and colleagues (2014) and Boyer et al. (2021) found high rates of suicide death among trans veterans compared to their non-trans counterparts. These

[1] Resources regarding best practices on collecting gender identity information at time of death can be found at https://www.lgbtmortality.com/resources.

two studies did not explore gender differences in mortality risk among trans cohorts, which is known to vary within non-trans populations (Ma et al. 2015) and may vary by gender within trans populations (e.g., trans men, trans women). Furthermore, these studies represent a select group—trans veterans—and cannot be generalized to the general trans population as veterans have elevated rates of mortality (Blosnich et al. 2014). Quinn and colleagues (2017) analyzed the insurance data of a subset of trans people enrolled in commercial insurance in Georgia and California. These researchers reported only the crude mortality rates of the trans cohort and a matched non-trans cohort, finding that trans people were at an increased risk of mortality compared to both non-trans men and non-trans women (Quinn et al. 2017). However, the researchers did not report age-specific rates, included only those who lived in Georgia or California, and relied on a crude identification algorithm known to be less sensitive than the one we apply here, hence limiting the study's generalizability (Jasuja et al. 2020; Quinn et al. 2017).

Purpose and Hypotheses

The purpose of this study was to compare the risk of mortality between trans and non-trans individuals enrolled in commercial insurance or Medicare Advantage plans between 2011 and 2019. We examined the risk of mortality while stratifying by gender modality (Ashley forthcoming) (e.g., non-trans, or people whose gender aligns with their sex typically assigned at birth, and trans, or people whose gender does not align with their sex typically assigned at birth) and gender expression. For gender, the non-trans population was categorized as male or female. We use "non-trans" rather than "cisgender" to reflect that while the people in this group may have a variety of gender modalities, we cannot confidently classify them as cisgender on the basis of the data. Given the limitations of the data source in not collecting gender identity, trans individuals could only be categorized into three distinct groups: trans masculine/nonbinary (TMN), trans feminine/nonbinary (TFN), and trans unclassified (see the next section for rationale and details). We had three primary hypotheses. First, given the severity of social stigmatization and high rates of suicidal ideation, victimization, and related morbidity in trans communities (James et al. 2016; White Hughto et al. 2015), we expected that all trans people would be at a higher risk of mortality at every age than their non-trans counterparts. Second, we expected TFN, TMN, and unclassified trans people to be at a greater risk than non-trans males and non-trans females at every age. Third, we expected that TFN people would have the greatest risk of mortality at every age relative to all other groups (Dinno 2017).

Methods

Data

We analyzed administrative claims data from Optum's Clinformatics® Data Mart Database, which includes deidentified insurance claims and death records for nearly 200 million commercially insured individuals and those enrolled in Medicare Advantage

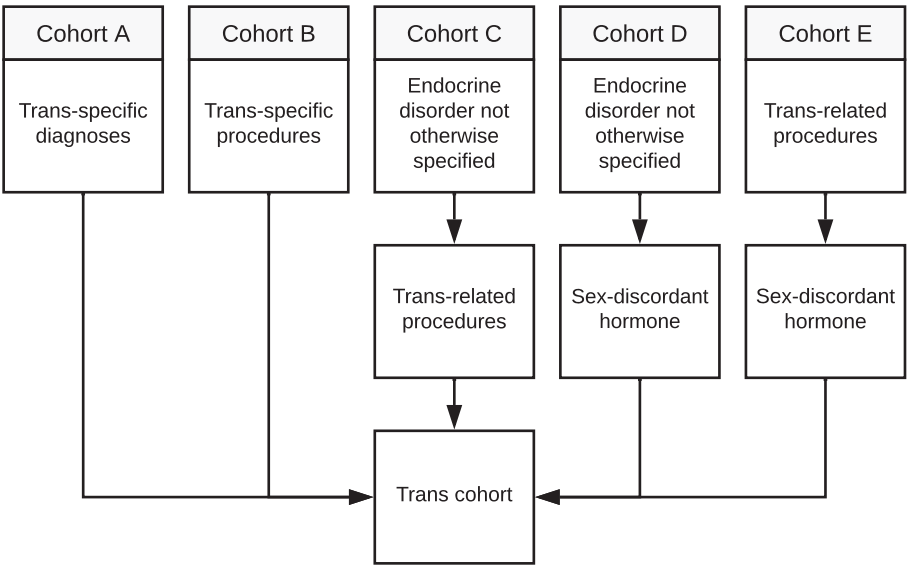

Fig. 1 Trans cohort inclusion diagram. The authors adapted the algorithm developed by Jasuja et al. (2020) by adding Cohort B: Trans-specific procedures.

plans from 2011 to 2019 across all 50 states and the District of Columbia (Jasuja et al. 2020). We linked enrollment information to claims data (e.g., ICD-9, ICD-10, CPT, Rx) to identify trans people and to identify age of death.

Sample

Our sample included all individuals identified as trans (see below for details on categorization) and a 10% random sample of non-trans individuals enrolled in private insurance or Medicare Advantage between 2011 and 2019. We restricted the sample to individuals aged 18 or over, which excluded 2,994 trans (about 10% of the overall trans sample) and 848,741 non-trans people (about 20% of the overall non-trans sample). Our analytic sample included 4,174,957 people, of whom 29,758 were identified as trans.

Identifying Trans Individuals

We identified trans individuals using an approach initially developed by Jasuja et al. (2020), which we further refined. Briefly, trans people were identified using a combination of International Classification of Diseases (ICD-9 and ICD-10) diagnostic codes specific to trans individuals (e.g., Gender Dysphoria and Gender Identity Disorder), Common Procedural Terminology codes for trans-related surgical procedures (e.g., vaginoplasty, phalloplasty), and prescription claims for gender-affirming hormones (see Figure 1 for more information). This algorithm builds on prior work that used trans-related ICD codes alone (Proctor et al. 2016) by also including individuals

who received an Endocrine Disorder Not Otherwise Specified diagnosis (Endo NOS) in conjunction with hormone prescriptions or trans-specific surgeries (Jasuja et al. 2020). Endo NOS is often used to bill for trans-affirming services instead of gender identity disorder to avoid the stigma of labeling the person as trans or to avoid denials of payment (Jasuja et al. 2020). Moreover, by incorporating the use of feminizing and masculinizing hormones and procedures, this algorithm allows the trans population to be stratified by gender. To ensure the algorithm's specificity, individuals who were included as trans because they had an Endo NOS diagnosis and were taking hormones above a certain threshold were required to have a gender marker at enrollment that was discordant with the hormone they were prescribed. For example, if an enrollee had an Endo NOS diagnosis, a female gender marker at enrollment, and an estrogen prescription over a certain threshold, we would not include this person as trans as their gender at enrollment was not discordant with the hormone they were prescribed (see Table 1 for example inclusion and exclusion criteria). While this approach likely removed trans people who changed their gender marker prior to enrollment from being included, it was necessary to retain the specificity of our sample. See Jasuja et al. (2020) for more information regarding these methods.

Gender Stratification

Stratifying the trans and non-trans cohorts by gender is necessary given that mortality is known to vary by gender in non-trans populations (Case and Paxson 2005). Additionally, Lagos (2018) found that, compared with trans men and women, gender nonconforming people were at the greatest risk for reporting poor health, a predictor highly correlated with mortality (DeSalvo et al. 2006). In this way, we suspect the mortality rates vary within trans populations by gender identity or expression. The crude stratification of the trans and non-trans samples by gender allows for critical health-related comparisons to be made within and across gender subgroups. Since insurance claims data do not include self-reported gender identity or expression, we stratified the trans cohort on the basis of their sex at enrollment and their use of "feminizing" or "masculinizing" hormones and surgeries. Specifically, *trans masculine and nonbinary people* refers to individuals with a female sex at enrollment who have received masculinizing hormones (e.g., testosterone) and/or procedures (e.g., mastectomy, phalloplasty, metoidioplasty). We include masculine and nonbinary in the gender label because trans individuals with a female sex who have affirmed their gender with masculinizing hormones or procedures may be seeking a nonbinary to masculine gender expression (Deutsch 2016). *Trans feminine and nonbinary people* are individuals with a male sex at enrollment who have received feminizing hormones (e.g., estrogen) and/or procedures (e.g., breast augmentation, vaginoplasty). We include feminine and nonbinary in the gender label because trans individuals with a male sex who have affirmed their gender with feminizing hormones or procedures may be seeking a nonbinary to feminine gender expression (Deutsch 2016). Trans individuals who received trans-specific diagnoses (e.g., gender identity disorder) but did not receive hormones or procedures or who had both masculinizing and feminizing hormones or procedures (e.g., testosterone and breast augmentation, or estrogen and phalloplasty) could not be categorized by gender spectrum and were coded as *trans unclassified*. Non-trans individuals were coded as *non-trans male* or *non-trans female*

Table 1 Descriptions of typical codes used for trans cohort inclusion and exclusion

Cohort	Description	Example Inclusion Codes	Example Exclusion
A	Trans-specific diagnoses	302.X (trans-sexualism), F64.X (gender identity disorders)	None
B[a]	Conclusive trans procedure code	64.5 (operations for sex transformation), 0W4N071 (creation of penis in female perineum)	None
C	Endocrine disorder not otherwise specified, Endo NOS (259.9, E34.9) plus procedure code	64.43 (construction of penis), 55175 (scrotoplasty)	Cancer exclusions: 183.X (malignant neoplasm of ovary), 186.X (malignant neoplasm of testis) Endo NOS exclusions: 243 (congenital hypothyroidism), 245 (thyroiditis)
D	Endocrine disorder not otherwise specified, Endo NOS (259.9, E34.9) plus discordant hormone prescription	Hormone discordant with sex at enrollment (e.g., testosterone and female sex at enrollment)	Estrogen exclusions: 398.91 (congestive heart failure), 428 (heart failure) Testosterone exclusions: 302.71 (hypoactive sexual desire disorder), 799.81 (decreased libido) Endo NOS exclusion: See Cohort C for Endo NOS exclusions
E	Discordant hormone prescription plus discordant procedure code	See Cohort D for hormone requirement 70.61 (vaginal construction), 54125 (amputation of penis), 0UTG0ZZ (resection of vagina)	See Cohort D for hormone exclusions Concordant sex with procedure code (F at enrollment with resection of vagina)

[a] The authors adapted the algorithm developed by Jasuja et al. (2020) by adding Cohort B: Trans-specific procedures.

by examining their sex listed at enrollment. We created these categories in close consultation with our community advisory board, composed of trans people from the Northeast, who provided input on the methods and terminology. We understand that these terms may not be frequently used by trans people as a means of self-identification; however, the community advisory board felt these terms and methods were the most accurate way to stratify our sample by gender expression.

Assessment of All-Cause Mortality

Optum collected month and year of death information from claims (e.g., discharge status being "expired," or reason for coverage discontinuation being "death") and data from the Social Security Administration's (SSA) Death Master File, which has been shown to have relative agreement with the National Death Index (Lash and Silliman 2001) and the Centers for Medicare and Medicaid Services (CMS). Optum linked enrollment information to SSA and CMS data using social security numbers plus one piece of information, such as name or date of birth. This study was reviewed and deemed exempt by the University of Michigan Institutional Review Board (HUM00161819).

Statistical Analyses

All analyses were conducted over age with time zero set at age 18. For non-trans individuals, the observed survival period began the day of their enrollment or the day they turned 18 and ended when they either disenrolled (administrative censoring) or died. To account for immortality time bias (i.e., bias due to observable periods where a death cannot occur) (Levesque et al. 2010), which has been present in other studies (Boyer et al. 2021), trans individuals' observed period began the day they were identified as trans or the day they turned 18 with a prior trans identification and ended when they either disenrolled or died. To ensure data were not identifiable, Optum truncated date of birth information of those over 89 years. Therefore, we recoded the last observed period for those over the age of 89 to 89.9, and any deaths that occurred over the age of 89 were not included. Thus, all individuals who survived to 89.9 were coded as right censored at age 89.9 with no mortality event.

All statistical analyses were conducted using Stata/MP 14.2. To test our first hypothesis—whether trans people were at a higher risk of mortality at every age than their non-trans counterparts—we fit Kaplan–Meier survival curves to our data, stratifying by gender modality (i.e., non-trans vs. trans), and performed log-rank tests for equality of survivor functions (Savage 1956). We also calculated age-cohort mortality rates per thousand along with standardized mortality ratios (SMRs) comparing the trans cohort to their non-trans counterparts. To test our second and third hypotheses—whether TMN, TFN, and unclassified trans individuals were at a greater risk of mortality at every age than both non-trans males and non-trans females, with TFN people being at the greatest risk compared to all groups—we fit Kaplan–Meier survival curves to our data, stratifying by gender and gender modality. We also calculated age-cohort mortality rates per thousand along with SMRs comparing the TFN, TMN, and unclassified trans cohorts to non-trans males and females.

Table 2 Survival summary statistics and census region by gender modality

	Trans (n=29,758)			Non-Trans (n=4,145,199)		
	Mean	SD	No. (%)	Mean	SD	No. (%)
Age of Entry	39	17		45	18	
Age of Exit	41	18		49	19	
Person-Years at Risk	2	2	58,525	3	3	13,871,208
Deaths (% of n)			724 (2.43%)			162,338 (3.9%)
Census Region[a]						
Midwest			6,798 (23%)			956,656 (23%)
Northeast			2,956 (10%)			457,531 (11%)
South			12,119 (41%)			1,830,125 (44%)
West			7,685 (26%)			831,874 (20%)

[a] Information on census region was missing for 69,213 people.

Results

Table 2 provides descriptive information about the sample and number of years of observation for the trans and non-trans cohorts. Our study included 5,035 TFN, 8,976 TMN, and 15,747 trans unclassified people, as well as more than 2 million non-trans females and 2 million non-trans males. Overall, we observed the trans cohort for 58,525 person-years and the non-trans cohort for over 13 million person-years. Trans people were six years younger at baseline, on average, than non-trans people (39 vs. 45) and eight years younger, on average, at their last observed time (41 vs. 49). While the trans and non-trans cohorts were similarly distributed in the Midwest and Northeast, trans people were overrepresented in the West (26%) and underrepresented in the South (41%) compared to the non-trans cohort (20% and 44%, respectively).

Comparing Trans and Non-Trans Cohorts

Figure 2 presents Kaplan–Meier survival curves comparing the trans and non-trans cohorts over age. Overall, trans people died at earlier ages than non-trans people. Twenty-five percent of the trans cohort died by the age of 69, compared with 25% of the non-trans cohort by the age of 75, and half of the trans cohort died by the age of 77, compared with half of the non-trans cohort by the age of 84. For a breakdown of the proportion survived by gender modality, see the first table in the online supplement.

Table 3 provides the estimated rates of mortality for 10-year age cohorts stratified by gender modality, along with SMRs. At every age, trans people were at higher risk of death than non-trans people, although between the ages of 30 and 39 the estimates did not reach statistical significance. Overall, trans people had nearly double the mortality rate of their non-trans counterparts (SMR = 1.80; CI = 1.67–1.93). Had the trans cohort experienced the same rate of mortality at each age as the non-trans cohort, we estimated that we would have observed 418 trans deaths; however, the observed number of trans deaths was 724 (significantly different at $p < .0001$). Thus, 42% of the observed deaths in the trans cohort are estimated to be excess deaths.

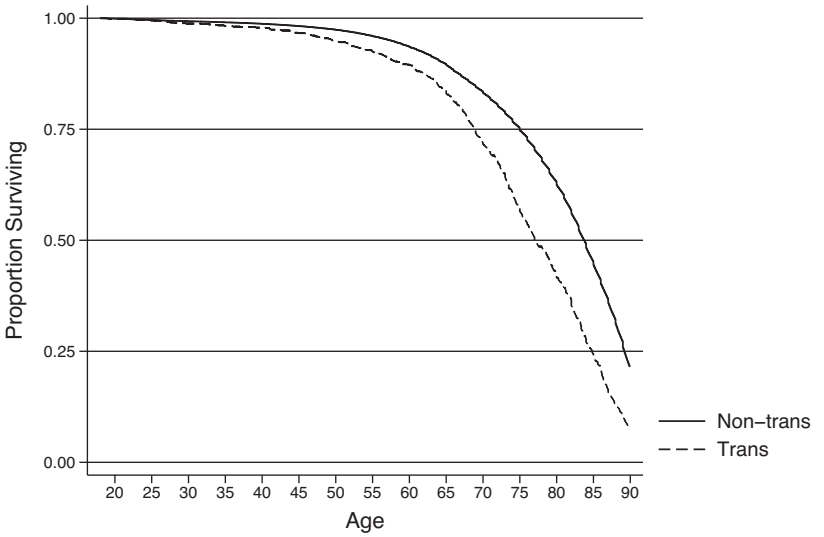

Fig. 2 Kaplan–Meier survival curves showing the proportion surviving by gender modality

Table 3 Rate of mortality by age cohort and gender modality

Age	Trans Mortality Rate (per 1,000)	Non-Trans Mortality Rate (per 1,000)	SMR (95% CI)
18–29	1.05	0.57	1.85 (1.15, 2.97)
30–39	0.92	0.60	1.55 (0.81, 2.98)
40–49	3.28	1.37	2.40 (1.72, 3.34)
50–59	5.85	4.04	1.45 (1.12, 1.87)
60–69	21.68	11.91	1.82 (1.55, 2.14)
70–79	52.35	27.05	1.94 (1.68, 2.24)
80–90	162.71	93.26	1.74 (1.55, 1.96)
Overall			1.80 (1.67, 1.93)

Note: SMR = standardized mortality ratio.

Comparing Trans and Non-Trans Cohorts Stratified by Gender

Figure 3 presents Kaplan–Meier curves comparing each cohort (i.e., non-trans males and females, TFN and TMN people, and trans unclassified people) over age. TFN and trans unclassified people experienced the worst mortality conditions over the life course. Among the TFN group, 25% died before the age of 63 and half died before the age of 75. Among the trans unclassified group, 25% died before age 67 and half

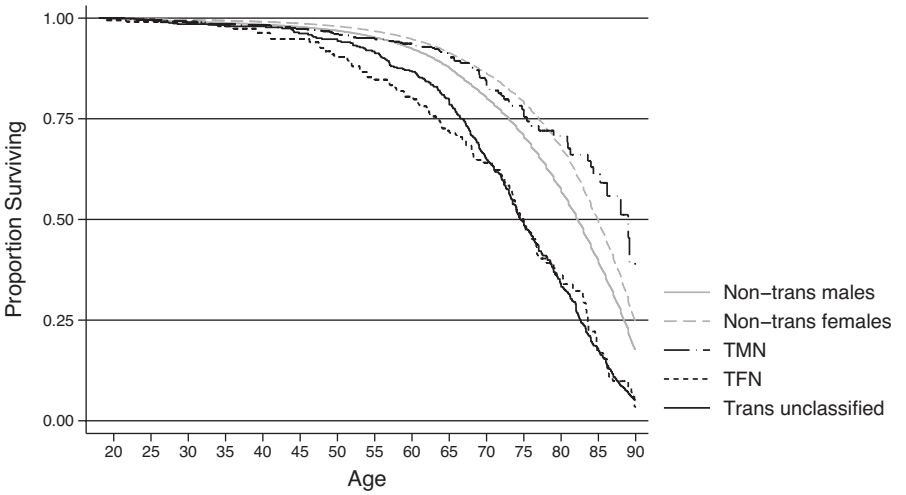

Fig. 3 Kaplan–Meier survival curves showing the proportion surviving by gender. TFN = trans feminine and nonbinary. TMN = trans masculine and nonbinary.

Table 4 Expected and observed deaths by gender

	TFN (111 observed)			TMN (81 observed)			Trans Unclassified (532 observed)		
Reference	Expected	Excess	% Excess	Expected	Excess	% Excess	Expected	Excess	% Excess
TFN				129*	−48	−59%	534	−2	0
TMN	63***	48	43				442***	90	17
Trans Unclassified	109	2	2	171***	−90	−111%			
Non-Trans Males	58***	53	48	121**	−40	−33%	304***	228	43
Non-Trans Females	42***	69	62	87	−6	−7%	235***	297	56

Notes: TFN = trans feminine and nonbinary. TMN = trans masculine and nonbinary. *p* values are derived from log-rank tests of equality.

*$p < .05$; **$p < .01$; ***$p < .001$

died before age 75. The rates of mortality for these two groups were significantly worse than those for both non-trans males and females. Overall, TMN people did not have significantly greater mortality rates than non-trans females, but they did have significantly better survival rates overall than non-trans males. For a breakdown of the proportion survived by gender, see the second table in the online supplement. As shown in Table 4, we also found that TFN and unclassified trans individuals experienced statistically higher rates of mortality overall than their TMN counterparts.

Table 5 provides the stratified estimated rates of mortality for 10-year age cohorts (except for ages 18–29), by gender. TFN and trans unclassified individuals were at

Table 5 Mortality rates and SMRs by age cohort and gender

	TFN (n=5,035)			TMN (n=8,976)			Trans Unclassified (n=15,747)			Non-Trans Females (n=2,105,888)	Non-Trans Males (n=2,039,311)
Age	Rate (per 1,000)	SMR: Non-Trans Males (95% CI)	SMR: Non-Trans Females (95% CI)	Rate (per 1,000)	SMR: Non-Trans Males (95% CI)	SMR: Non-Trans Females (95% CI)	Rate (per 1,000)	SMR: Non-Trans Males (95% CI)	SMR: Non-Trans Females (95% CI)	Rate (per 1,000)	Rate (per 1,000)
18–29	0.64	0.86 (0.20, 3.40)	1.65 (0.40, 6.60)	0.94	1.27 (0.48, 3.39)	2.44 (0.92, 6.51)	1.25	1.68 (0.93, 3.03)	3.22 (1.78, 5.82)	0.39	0.74
30–39	2.63	3.60 (1.35, 9.59)	5.77 (2.16, 15.37)	0.57	0.78 (0.20, 3.12)	1.25 (0.31, 5.00)	0.63	0.87 (0.28, 2.69)	1.39 (0.45, 4.31)	0.46	0.73
40–49	6.82	4.33 (2.17, 8.66)	5.87 (2.94, 11.74)	2.34	1.49 (0.88, 2.51)	2.02 (1.19, 3.40)	3.71	2.35 (1.37, 4.05)	3.19 (1.85, 5.50)	1.16	1.57
50–59	11.91	2.51 (1.49, 4.24)	3.58 (2.12, 6.05)	2.49	0.53 (0.31, 0.91)	0.75 (0.44, 1.29)	8.66	1.82 (1.29, 2.58)	2.60 (1.84, 3.68)	3.33	4.74
60–69	22.56	1.57 (1.07, 2.31)	2.32 (1.58, 3.40)	10.36	0.72 (0.48, 1.08)	1.07 (0.71, 1.59)	29.73	2.07 (1.69, 2.54)	3.06 (2.49, 3.74)	9.73	14.35
70–79	54.95	1.71 (1.21, 2.42)	2.40 (1.69, 3.39)	16.38	0.51 (0.30, 0.88)	0.71 (0.41, 1.23)	64.88	2.02 (1.71, 2.38)	2.83 (2.40, 3.34)	22.94	32.16
80–90	195.95	1.97 (1.33, 2.92)	2.19 (1.48, 3.24)	39.46	0.40 (0.22, 0.72)	0.44 (0.24, 0.80)	186.05	1.87 (1.65, 2.13)	2.08 (1.83, 2.36)	89.45	99.23
Overall		1.89 (1.57, 2.27)	2.57 (2.13, 3.10)		0.64 (0.52, 0.80)	0.87 (0.70, 1.08)		1.93 (1.77, 2.10)	2.45 (2.25, 2.67)		

Notes: TFN = trans feminine and nonbinary. TMN = trans masculine and nonbinary. SMR = standardized mortality ratio.

the greatest risk of mortality overall. Compared with non-trans males, TFN people were at an 89% increased risk of mortality overall (SMR = 1.89; CI = 1.57–2.77), with much of the difference being attributed to risk between the ages of 30 and 49 years (SMRs of 3.60 and 4.33, respectively). Compared with non-trans females, TFN people were at a 157% increased risk of mortality throughout the entire period (SMR = 2.57; CI = 2.13–3.10), with significantly greater risk at every age except 18–29. Trans unclassified people were at a greater risk of mortality compared with non-trans males, having a comparative SMR of 1.93 (CI = 1.77–2.10); when compared with non-trans females, they had an overall SMR of 2.45 (CI = 2.25–2.67), with the highest SMR for ages 18–29 (3.22; CI = 1.78–5.82). Finally, TMN people were less likely to die overall, with an overall SMR of 0.64 (CI = 0.52–0.80) when compared with non-trans males. We did not find TMN people to have significantly different mortality rates than non-trans females, although we did document elevated risk between the ages of 40 of 49 (SMR = 2.02; CI = 1.19 –3.40). TMN peoples' mortality rates relative to both non-trans males and females seemed to decline with age as their relative SMRs decreased in older ages.

Discussion

The National Academy's Committee on Understanding the Well-Being of Sexual and Gender Diverse Populations (National Academies of Sciences, Engineering, and Medicine 2020) has specifically called for research on the mortality conditions of trans populations. To our knowledge, this national study helps to fill this gap by presenting and comparing some of the first age-specific mortality rates for trans and non-trans U.S. populations using commercial insurance data. Findings from this study highlight important areas for future research to better understand and address disparities in mortality among trans populations. Overall, we found substantial mortality disparities between the trans and non-trans cohorts, as well as between trans subsamples. Evidence suggests that private insurance is the most common form of coverage among some subgroups of trans populations, such as White trans people (James et al. 2016); thus, our findings may be more generalizable than previously reported mortality studies with trans and non-trans populations receiving care through the Veterans Health Administration (Blosnich et al. 2014; Boyer et al. 2021). Our use of national data also makes these findings more representative than prior geographically limited research with trans and non-trans individuals in Georgia and California (Quinn et al. 2017). These findings underscore the need for future prospective research to understand the mechanisms that may be driving the mortality disparities observed here. This research can also be used to inform future intervention efforts aimed at improving the material, social, and health conditions of trans people in the United States as a means to reduce these documented mortality disparities. Trans deaths, particularly those resulting from violence, are simultaneously sensationalized and obscured in the media, driving a societal hyperawareness of trans victimhood without much accompanying effort to change the social conditions that lead to these deaths (Westbrook 2021). We hope that our study emphasizes the urgent need to invest in the health and well-being of trans people in the United States to reduce mortality disparities.

As hypothesized, we found that trans people are at greater risk of mortality at nearly every age compared with their non-trans counterparts. Indeed, at each of the age intervals examined, the trans cohort had significantly higher mortality rates than the non-trans cohort, except for ages 30–39, and the overall rate of mortality was nearly twice as a high among the trans sample than among the non-trans sample. Moreover, we found that the median life expectancy was seven years shorter for trans people than for their non-trans counterparts. These findings provide evidence that some trans and non-trans populations experience substantially different mortality conditions overall and across the life course. Our evidence corroborates Blosnich et al. (2014) and Quinn et al. (2017): overall, trans people experienced greater mortality risk than their non-trans counterparts as revealed in claims data. Yet these findings diverge from those of Boyer et al. (2021), who found that trans veterans experienced less all-cause mortality than their non-trans counterparts. However, Boyer et al. (2021) did not account for immortal time bias (Levesque et al. 2010), which may have deflated the risk among trans-identified cohorts.

Research suggests that anti-trans stigma reduces trans peoples' access to health care, housing, and employment while increasing interpersonal violence, excess stress, and hypervigilance (Hendricks and Testa 2012; Hughes et al. forthcoming; White Hughto et al. 2015). In particular, research has documented the health costs of high-effort coping with adversity—such as the sustained cognitive and emotional engagement required to persevere in the face of discrimination—among socially marginalized groups that may result in early morbidity and mortality (Bennett et al. 2004; Geronimus 1992; Geronimus et al. 2006; Geronimus et al. 2020; Geronimus et al. 2015; James 1994). For example, trans people may face discrimination in housing, employment, or social circles that requires taxing cognitive and emotional engagement and contributes to poor health outcomes (White Hughto et al. 2015). Given the nature of claims data, we were unable to assess the relationship between anti-trans stigma, coping, and mortality risk in this sample. Thus, longitudinal cohort studies are needed to explore anti-trans stigma and other drivers of health inequities on mortality among trans populations. Such studies would allow researchers to establish the temporal relationship between anti-trans stigma and mortality for trans populations and continue to uncover the mechanisms through which stigma operates to inform intervention efforts.

Findings from this study largely supported our hypotheses related to differences in mortality risk by gender subgroup. Consistent with our second hypothesis, TFN people were at increased risk of mortality compared with both non-trans males and females at nearly all ages. Additionally, we found that the overall standardized rates of mortality among TMN were statistically better than those of non-trans males, but were not statistically different from those of non-trans females overall, which does not support our second hypothesis. Notably, however, when exploring specific age intervals, we found that between the ages of 18 and 29, TMN people experienced over a twofold increased mortality risk compared with non-trans females, which suggests this may be a particularly vulnerable period for TMN people. This difference was not statistically significant, which may be due to our small sample size during this period rather than actual risk. Prior research has documented higher rates of self-injury and suicidal ideation among young (ages 18–29) TMN people than among their non-trans peers (James et al. 2016; Marshall et al. 2016); thus, it is possible that death by suicide may be driving

these age-related disparities. Future research should focus on capturing the cause of death to understand the drivers of these disparities.

In addition to the between-group disparities observed, we found that TFN individuals were at greater risk of mortality than their TMN counterparts. Moreover, although recent data suggest that TMN people are at a greater risk of morbidity than their TFN peers (Hughes et al. 2021), our analyses suggest that TFN people are at a greater risk of morbidity than their TMN peers. This finding is analogous to the gender paradox described in cisgender populations, in which cis women experience greater risk of morbidity but improved survival outcomes (Case and Paxson 2005; Nathanson 1975). Prior studies have documented particularly high risks of homicide, substance use, and chronic health conditions among trans women, which may be driving the differences in the risk of mortality observed here (Becasen et al. 2019; Dinno 2017; Downing and Przedworski 2018; Hughto et al. 2021; Jasuja et al. 2020). Further, although other research has reported comparable or even higher rates of suicide attempts among trans men in comparison to trans women, one study conducted in the Netherlands found that the incidence of death by suicide among trans women was more than twice that of trans men (Marshall et al. 2016; Wiepjes et al. 2020). Future research is needed to explore the causal mechanisms underlying mortality disparities between trans women, trans men, and non-binary people so that interventions can be developed to prevent premature death among these populations.

Future mortality studies with trans populations should stratify analysis by gender identity (or when not possible, by gender expression) and consider exploring other population-level factors such as race, ethnicity, class, and migration status, which may interact with gender modality to affect mortality risk. In particular, researchers might focus on examining the mortality conditions of trans women of color, who are at high risk of violence, homicide, HIV, and post-traumatic stress and other mental health conditions that may drive excess mortality when compared to other trans populations (Becasen et al. 2019; Dinno 2017; Poteat et al. 2016; Reisner et al. 2016; Sherman et al. 2020).

Given the necessary use of masculinizing and feminizing hormones or procedure claims to categorize the gender expression (e.g., TFN vs. TMN) of trans individuals, we were unable to classify 53% of the trans sample according to gender (trans unclassified). Notably, however, we found that this subset of the trans sample had among the greatest risk of mortality, similar to the risk of TFN people. It is possible that this unclassified group may contain a greater percentage of trans people who do not desire medical gender affirmation (leading them to have an unidentified gender expression in our algorithm) and have increased mortality risk because of the increased anti-trans stigma associated with gender nonconformity or a nonbinary identity (Miller and Grollman 2015) and expression (Reisner et al. 2015). It is also possible that such individuals have higher rates of chronic medical conditions that preclude them from accessing medical forms of gender affirmation—conditions that are also associated with increased mortality (e.g., untreated serious psychological illness, prior venous thrombosis, end-stage chronic liver disease) (Coleman et al. 2012). Additionally, prior research has found that lack of access to medical gender affirmation is associated with poor physical and mental health, as well as suicidality (Coleman et al. 2012; Glick et al. 2018; Nemoto et al. 1999; Sanchez et al. 2009; White Hughto et al. 2015). Thus, if individuals in this group desire medical gender affirmation but are

unable to receive it owing to geographic, financial, social, or medical barriers, they may be at greater risk for morbidity and mortality relative to the other trans subgroups in our sample who were able to access medical gender affirmation and be classified according to gender expression (Wilson et al. 2015). Our work highlights the need for government, administrative, and population health surveillance systems to collect appropriate gender identity data. Demographic studies have the opportunity to provide vital statistics to estimate mortality and morbidity in the general population. With few exceptions (Downing and Przedworski 2018; Meyer et al. 2017), existing surveillance efforts do not collect individuals' gender identity, which continues to erase trans people and foreclose empirical analysis of many important questions. Large national data sets that contain indicators of gender identity and cause of death are therefore needed to better characterize mortality risks among trans subgroups relative to their non-trans counterparts.

Limitations

Important limitations stem from our use of insurance claims for this study. Our sampling frame included only those with commercial insurance or enrolled in Medicare Advantage; it did not include individuals with other forms of public or private insurance or uninsured individuals. Since people with commercial insurance tend to be healthier than those with public insurance or none, we expect that the disparities observed here would be even more pronounced if we were to sample from the general population. Furthermore, not all deaths among those in our study were captured by Optum's claims data. Starting in 2011, some states stopped contributing dates of death to the SSA office out of privacy concerns, prompting Optum to stop using state-reported information for the SSA Death Master File in 2011, causing a 30% drop in reported deaths. Therefore, the results of this study reflect deflated estimates of the true age of death. However, it is unlikely that this impacted date of death reporting for trans and non-trans people differentially, meaning our estimates of mortality disparities are unlikely to be biased by this limitation.

Additionally, these data did not contain reliable information about individuals' gender identity or sex assigned at birth, introducing further bias (Kronk et al. 2021). The algorithm we used to identify trans individuals is likely insensitive because (1) not all trans people seek gender-affirming health care; (2) in some cases, gender-affirming health care is indistinguishable from routine health care; and (3) not all trans people with insurance access gender-affirming care because of lack of availability or trust in medical care systems (Glick et al. 2018). Thus, this sample represents a subset of trans people who were engaged in a particular set of gender-affirming health care practices over the study period and is not representative of the entire trans population. However, gender-affirming care has been linked to better health outcomes (Keo-Meier et al. 2011; Murad et al. 2010; White Hughto and Reisner 2016; Wilson et al. 2015), thus we expect that the disparity in mortality observed here would be even more pronounced had we been able to include trans individuals who had not received a diagnosis, procedure, or prescription that we were able to capture. Moreover, given that the trans population is estimated to be 0.6% of the U.S. population (Flores et al. 2016), the inclusion of some trans people into the non-trans cohort was unlikely to meaningfully affect mortality

estimates. Although prior research has included intersex people under the trans umbrella (James et al. 2016), given that we do not know how participants identify, it is possible that individuals who identify as intersex and do not consider themselves to be trans were included in the trans cohort if they did not have a trans diagnosis code, had received an endocrine NOS code, or were taking sex-discordant hormones at a level consistent with those used for gender-affirming care. Lastly, we defined the subpopulations within the trans cohort as trans masculine/nonbinary and trans feminine/nonbinary on the basis of their sex at enrollment and use of feminizing or masculinizing hormones and procedures. This categorization may not have accurately captured their sex assigned at birth and does not reflect gender identity. As a result, we were unable to examine mortality disparities across multiple gender identity subgroups (e.g., nonbinary vs. trans men vs. trans women).

Conclusion

To our knowledge, this is one of the largest studies to document within-group and between-group disparities in mortality among U.S. trans and non-trans populations. Trans people in our study had significantly higher rates of mortality at nearly every age than their non-trans counterparts. We also found significant variation of mortality risk within subpopulations of trans people, with the trans feminine/nonbinary and trans unclassified groups being at the greatest risk of mortality. These findings highlight the need to collect more robust gender identity data in mortality surveillance systems to allow for more nuanced future research. Such research could also be used to inform the development of public health interventions to prevent early mortality among trans populations in the United States. ■

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