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Examining the mortality risk of a population with mental illness

Glorimar Ortiz
Walden University

Walden University

College of Health Sciences

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Glorimar Ortiz

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Review Committee
Dr. Mary Lou Gutierrez, Committee Chairperson, Public Health Faculty
Dr. German Gonzalez, Committee Member, Public Health Faculty
Dr. Robin Sneed, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2020

Abstract

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by

Glorimar Ortiz

MS, University of Puerto Rico, 2011

BS, University of Puerto Rico, 1993

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Individuals with mental illness experience increased mortality and premature death. In a sample composed of 88% decedents with mental illness who were Black, the findings from three research studies provided insight about excess and premature mortality, odds of dying by cause of death, and risk factors associated with premature mortality. The purpose of this quantitative study was to examine the mortality of a population group with mental illness that was served in a public mental health system (PMHS). The ecoepidemiological life course framework for health, disease, and mortality was used to link mechanisms that may influence health and longevity in space and time among this population group. From 2010 to 2014, 22,668 deaths occurred in the general population, 5% of which were from individuals who were served in the PMHS. Using the indirect standardization method it was found that people with mental illness served in the PMHS experienced excess mortality (*SMR* = 1.78). Persons with mental illness also experienced premature death (*YPLL* = 23 years). Risk of dying due to unnatural causes of death by unintentional injury or accidents (*OR* = 2.46) was associated with mental illness. Using multiple regression four predictive risk factors accounted for 15% of the variance in premature mortality among people with mental illness served in the PMHS: being female, Black, never married, and tobacco user. Persons served in the PMHS continue to be affected by their mental illness. The greatest impact of experiencing mental illness is loss in life expectancy. Findings may encourage solutions to decrease the mortality due to accidents among people with mental illness. This may prolong the longevity of this population group, and may improve the overall health status of the general population.

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APA 6

Dedication

All the glory be to God who gave me the wisdom to complete this milestone and that blessed me with individuals that cared for me through this indescribable journey. I dedicate this work to:

The wind beneath my wings for supporting and believing in me…my Gogi, my husband Wil.

My pride and joy because they are my inspiration to continuously be a better human being…my sons Wil Jr & Ema.

To my angel on earth for her unceasing prayers and never-ending encouragement…my Mami, Gloria.

Acknowledgments

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Part 1: Overview

Introduction

Mortality-based measures are used as indicators of population health status. Increased mortality risk has been observed among population groups suffering from mental illness (Chesney, Goodwin, & Fazel, 2014; Hayes, Miles, King, & Osborn, 2015; Laursen, Nordentoft, & Mortensen, 2014; Oakley et al., 2018; Walker, McGee, & Druss, 2015). Excess mortality is measured by estimating standardized mortality ratios (*SMRs*) that determine the ratio between observed and expected number of deaths. SMRs for persons with mental illness are estimated between 1.92 and 5.91 (Charrel et al., 2015; Daumit et al., 2010; Heiberg et al., 2018; John et al., 2018; Krupchanka, Mladá, Winkler, Khazaal, & Albanese, 2018; Miller et al., 2006; Papas et al., 2015; Plana-Ripoll et al., 2019; Sherman et al., 2013). Premature mortality is measured by estimating years of potential life lost (*YPLL*) which considers people's life expectancy. Persons with mental illness are more likely to die 10-25 years earlier than persons in the general population (Chesney et al., 2014; Kondo et al., 2017; Laursen et al., 2014; Lesage et al., 2015).

Understanding current estimations of mortality risks in mental illness is appropriate because mental illness represents the greatest mortality burden (Walker et al., 2015). It provides knowledge about the impact of the problem. It also poses challenges in terms of their application regarding less investigated population groups. The application of the available knowledge on mortality indicators may be restricted if it cannot be used to delineate efforts preventing early mortality in distinct settings of care.

Problem Statement

Individuals with mental illness experience premature mortality 10-25 years earlier compared to individuals in the general population (Chesney et al., 2014; Kondo et al., 2017; Laursen et al., 2014; Lesage et al., 2015). Surveillance regarding excess and premature mortality among people with mental illness has been observed in diverse settings of care. Evidence from studies provide insights about mortality risks among individuals with mental illness. In population-based studies, the care setting was identified from national registries from which data were analyzed. Krupchanka et al. (2018), Osby et al. (2016), and Lumme et al. (2016) found greater mortality in samples from individuals with severe mental illness who were served in inpatient settings than from individuals in the general population. Charrel et al. (2015) argued that the excess mortality (*SMR* = 3.89) observed among individuals with all psychiatric disorders, not exclusively severe mental disorders, served in public inpatient hospitals was also elevated. Heiberg et al. (2018), John et al. (2018), and Plana-Ripoll et al. (2019) combined data from individuals served in inpatient and outpatient settings to offset the observed greater mortality risk in inpatient samples and reported SMRs for schizophrenia cohorts ranging from 2.6 and 4.9. Regardless of the setting of care, increased mortality risk among populations with mental illness has persistently endured over time, and this public health problem may have worsened (Oakley et al., 2018).

U.S. public mental health systems (PMHSs) tend to serve people who are most severely mentally ill (Fisher et al., 2009). Many of served individuals are homeless and do not have social support systems (Shan & Sandler, 2016). PMHSs also experience

continuous mental health care reforms and changes in policy that may have an effect on the mortality status of the served population. Researchers explored the mortality risk of individuals with mental illness that were treated in the Ohio PMHS. Miller et al. (2006) focused the investigation to an inpatient sample and reported elevated excess mortality (*SMR*= 3.2) and premature death (*YPLL* = 32 years) for persons served in the Ohio PMHS compared to the Ohio general population. Sherman et al. (2013) and Piatt et al. (2010) argued that inpatient samples are associated with higher mortality metrics thus they examined the mortality risk among non-inpatient samples also served in the Ohio PMHS. Sherman et al. (2013) reported almost six-time fold (*SMR* = 5.91) the mortality risk than the mortality risk in the general population. Piatt et al. (2010) reported greater premature mortality (*YPLL*= 14.5 years) for individuals treated in the Ohio PMHS compared to the mortality in the city of Akron, Ohio.

Daumit et al. 2010 (2010) investigated the pattern of mortality among a predominantly Black sample (51%) with severe mental illness that received benefits from the Maryland Medicaid system and found greater excess mortality (*SMR*= 3.7) compared to Maryland residents not Medicaid eligible. Papas et al. (2015) identified risk factors of premature death among persons with mental illness who were Medicaid beneficiaries in Delaware. Mortality risk estimates from Ohio and Delaware PMHSs were from population samples that were mainly composed of White decedents. Papas et al. (2015) and Daumit et al. (2010) examined mortality data from Medicaid enrollees who are considered at greater mortality risk.

The current study involved mortality in a PMHS responsible for providing public mental health services including prevention, intervention and treatment services, and support for people suffering from mental disorders. All individuals who were served in the PMHS under study and died between January 1, 2010, and December 31, 2014 were included for analysis regardless of service type. The overall population group served in the PMHS under study is mainly Black (91%), and only 5% of the served individuals are considered seniors (65 years and older). Wik, Hollen, and Fisher (2017) found that the PMHS under study had the highest rate (55 per 100,000 adult civilians) at which forensic patients or those involved with the criminal justice system were admitted to inpatient psychiatric care compared to other PMHSs in the U.S. (median of 10 per 100,000 civilians).

Shiels et al. (2018) examined mortality data from the U.S. general population and reported up to 3.9% declined in premature mortality among Black individuals an overall improvement in mortality outcomes compared to White counterparts. However, Black groups experienced 1.5 times greater mortality than White groups (Shiels et al., 2017). Therefore, it is important to examine the mortality status of individuals served in an understudied PMHS for the formulation of preventative efforts. It is also important to understand if overall improvements in mortality outcomes observed among Black groups in the U.S. general population translate into specific population groups such as groups of individuals with mental illness served in the PMHS. In addition to understanding the mortality risk of a population group with mental illness served in a PMHS by estimating mortality indicators, I explored predictors of premature mortality. Under an

ecoepidemiological life course framework for health, disease, and mortality various levels of causation (e.g., distal, intermediate, and proximal) were expected to influence the mortality outcome. Therefore, expanding on Papas et al. (2015) who centered their work mainly on distal factors associated to the Medicaid system, I included in a predictive model a distal factor (time to death after the last service date); an intermediate factor (tobacco use), and five proximal risk factors (gender, race, educational level, Medicaid eligibility, and marital status).

Purpose of the Study

The main purpose of the study was to examine the mortality of a population group with mental illness served in a PMHS. Risks were measured using indicators of mortality such as SMR, YPLL, and odds ratio (*OR*) (which estimates the risk of dying when the cause of death is present versus when it is absent). I first investigated the relationship between being served in a PMHS and experiencing excess (*SMR*) and premature (*YPLL*) mortality. I also adjusted, by gender and race, the magnitude of YPLL and estimated how many more years an individual served in the PMHS under study may lose due to early mortality compared to an individual in the general population.

Second, I explored the relationship between mental illness and risks for all- and specific-cause of death. The all-cause mortality was estimated by including all deaths. Deaths were also grouped by specific causes of death. SMRs and YPLL were estimated for natural (e.g., cardiovascular disease, cancer, respiratory disease, infections, diabetes mellitus, Alzheimer disease, and other diseases) and unnatural (e.g., suicide, accidents, and assaults) causes of death. I estimated ORs for individuals served in the PMHS under

study by all- and specific-cause of death. I also explored SMRs by cause of death by gender, race, and age for the population group served in the PMHS under study. Finally, I estimated the predictive relationship between distal (time to death after last service date), intermediate (tobacco use), and proximal (gender, race, educational level, Medicaid status, and marital status) factors and premature mortality.

Social Impact

The findings of this study may help to decrease the health inequalities in care experienced by individuals with mental illness served in a PMHS. Information can be used to prioritize policy and health promotion. For individuals served in the PMHS under study, the information may provide insights regarding treatment modification and evidence-based practices. For clinical staffs at the PMHS, it may yield specificity about the population groups that are prone to greater mortality risk. For the PMHS as a system of care, the findings may elucidate information for the better allocation of resources. Findings may encourage solutions that may decrease the mortality risk faced by this vulnerable population group. This has the potential of prolonging the longevity by increasing the life expectancy of individuals with mental illness served in PMHSs and of improving the overall health status of the general population.

Background

Mortality has been used as a measure to quantify the health of populations and burden of diseases. However, it is important to understand how mortality risks have been measured among population groups to assess their applicability to less investigated groups. This section includes a description of mortality-based indicators frequently used

to measure population health and the relationship between excess and premature mortality and mental illness, as well as how this relationship has been monitored in international, national, and local settings of care.

Mortality-Based Indicators

Mortality-based indicators collect death data that is fundamental for identifying population needs and prioritizing population resources. Frequently used mortality-based measures in research with samples of individuals with mental illness includes SMR and YPLL. These measures provide a direct indication of risks of excess mortality and premature death, and an indirect indication of how it could be prevented.

Excess and Premature Mortality and Mental Illness

Excess mortality occurs when the number of observed deaths in a particular population group exceeds the number of expected deaths based on the death rate in the general population. Premature mortality occurs when an individual die before an expected age. Excess and premature mortality have been observed among population groups served in PMHSs who suffer from severe mental illness (SMI). According to the American Psychological Association (APA) (2019), SMI encompasses a cluster of chronic conditions characterized by impairments in cognition, mood, and social interactions or a combination of these.

In a health-illness spectrum diagram, a SMI disorder (e.g., schizophrenia, major depression, or bipolar disorder) can be numerically characterized according to the level of impairment. A scale ranging from 1 or lower impairment (greater health) to 5 or greater impairment (greater illness) is used to denote the disorder. Figures 1, 2, and 3 show that

in the health-illness spectrum, SMI disorders rank higher in impairment as measured by higher number in the scale. Schizophrenia, bipolar disorder, and major depression are placed in number 5 which indicates greater illness or impairment. People with schizophrenia experience psychosis and detachment compared to people classified as number 1 who have good reasoning and are sociable and confident. Individuals with schizophrenia are more withdrawn, quiet, and shy. People with major depression or bipolar disorders are also categorized in the highest impairment level or number 5. Individuals with major depression or bipolar disorders also experience psychosis and detachment, as well as depressed mood.

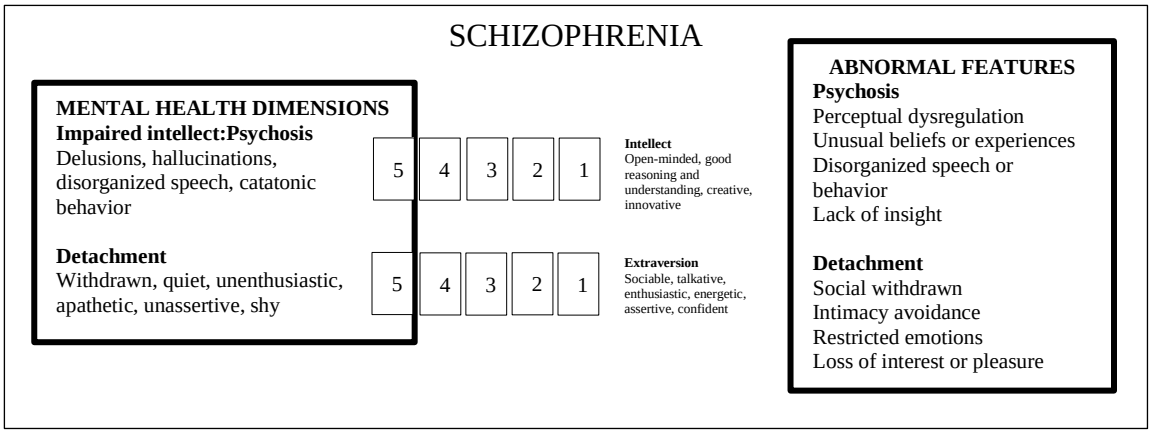

Figure 1. Adapted version of the health-illness spectrum for schizophrenia. Developed by P. W. Long. Copyright 1995-2019 by Internet Mental Health.

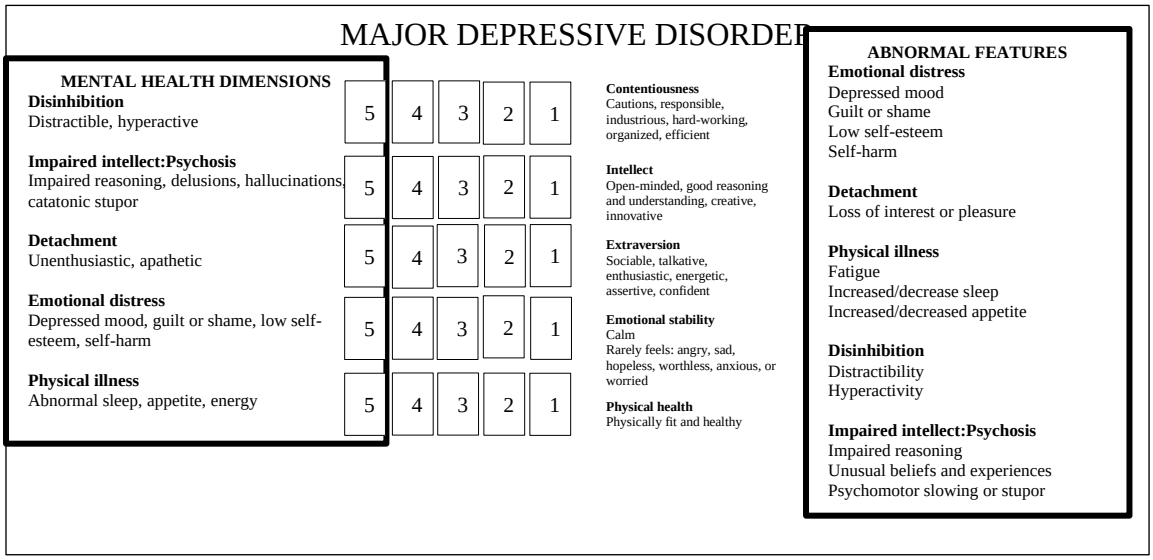

Figure 2. Adapted version of the health-illness spectrum for major depressive disorder. Developed P. W. Long. Copyright 1995-2019 by Internet Mental Health.

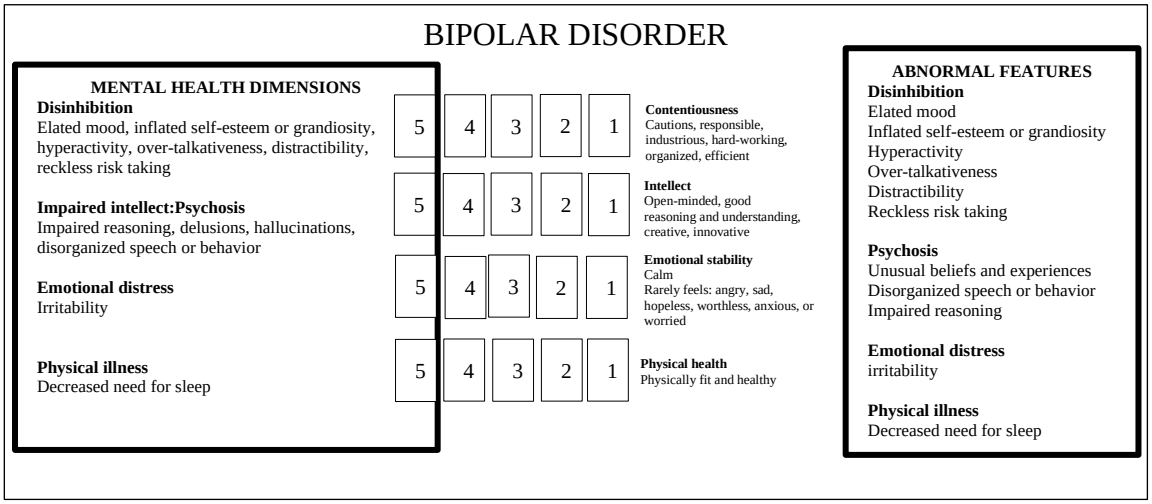

Figure 3. Adapted version of the health-illness spectrum for bipolar disorder. Developed by P. W. Long. Copyright 1995-2019 by Internet Mental Health.

Globally, major depression affects 300 million people, bipolar disorder affects 60 million people, and schizophrenia affects 23 million people (World Health Organization [WHO], 2018). In the U.S., one in 25 adults experience SMI each year (National Alliance on Mental Illness [NAMI], 2019). Nearly 18 million experience major depression, seven million experience bipolar disorder, and two million are affected by schizophrenia (NAMI, 2019). More than two million excess deaths have been estimated for persons with major depression, along with more than one million for persons with bipolar disorder and nearly 700,000 excess deaths in persons with schizophrenia (Charlson et al., 2014).

Individuals with SMI have been positively screened for grave dysfunction which can cause public health concern due to detrimental effects for individuals, communities, and society in general (Patel et al., 2016). Estimates of excess mortality vary according to the severe mental disorder with schizophrenia cohorts facing an elevated morality risk than bipolar or depressed cohorts. For example, Oakley et al. (2018) found greater excess mortality risk (*SMR* = 3.08; 95% *CI*, 2.35-2.75) in a cohort of people with schizophrenia diagnosis compared to a cohort of people in the general population. Hayes et al. (2015) reported also excess mortality in a cohort of people with bipolar disorder (*SMR* = 2.05; *95% CI* = 1.89-2.23) relative to a nonbipolar cohort, however the estimate was lower than the schizophrenia cohort. Chang et al. (2010) also reported increased excess mortality in a depressed cohort (*SMR* = 1.29; *95% CI* = 1.19-1.40) relative to a nondepressed cohort, but even lower than estimates from schizophrenia and bipolar cohorts.

The mortality risk is still higher for any of the mental health diagnoses when compared with the mortality risk for individuals in the general population. In terms of premature mortality, adults with SMI experience a reduced life expectancy, dying 10-25 years earlier than adults in the general population (Chesney et al., 2014; Colton & Manderscheid, 2006; Kondo et al., 2017; Laursen et al., 2014).

Treatment for Mental Illness

Treatment for people with mental illness may be delivered in different settings. A recovery-oriented model of mental health emphasizes that a person can recover from a mental health condition and encourages psychiatric care in outpatient or community-based settings (APA, 2020). However, individuals with mental illness may also need inpatient care due to the severity of their illness. In 1908, the primary locus of care for individuals with mental illness were public inpatient settings consisting of large and isolated institutions serving mainly long-term care patients. Between 1950s and 1960s, after the National Mental Health Act became law, a shift in national policy about the treatment of mental disorders occurred and individuals receiving mental health treatment in inpatient settings were gradually deinstitutionalized into outpatient or community-based programs. Mental health advocates expected an improvement in mortality-based measures (i.e., excess and premature mortality) as the recovery-oriented model emphasizes a holistic view of the life of persons suffering from mental illness, supports community-based services, and is founded on evidence-based practices.

Population Groups with Mental Illness Served in PMHSs

Population groups with mental illness who receive psychiatric treatment in PMHSs are of public health concern not only because they experience greater severity and impairment but because they also experience greater disparity in the social determinants of health than population groups not treated in PMHSs putting them at higher risk of experiencing excess and premature mortality. Groups with mental illness who are served in PMHSs tend to have lower incomes and educational levels, be unemployed, and have unstable living arrangements than groups not served in PMHS (Burgess, Curtis-Downes, & Gibson, 2013; Shan & Sandler, 2016). People served in PMHSs are also more likely to smoke and drink heavily and have unhealthy diets (Dipasquale et al., 2013; Toftdahl, Nordentoft, & Hjorthoj, 2016; Vancampfort, Stubbs, Venigalla, & Probst, 2015). Persons with mental illness tend to be sicker than persons in the general population (Druss, Zhao, Esenwein, Morrato, & Marcus, 2011). Public health leaders have paid close attention to groups with mental illness in PMHSs in an effort to improve mortality risks.

Global Surveillance for Mortality in Population Groups with Mental Illness

Several researchers have monitored the mortality risk experienced by people with mental illness. Recent information about this public health problem comes from population-based studies conducted in industrialized countries that have implemented universal healthcare systems and data were collected from national registries. For example, Krupchanka et al. (2018), Osby et al. (2016), and Lumme et al. (2016) analyzed mortality data from individuals with SMI who were served in inpatient settings

in Czech Republic, Sweden, and Finland, respectively. Charrel et al. (2015) expanded their investigation on mortality among individuals with all psychiatric disorders served in public inpatient hospitals in France. Heiberg et al. (2018); John et al. (2018), and Plana-Ripoll et al. (2019) analyzed mortality data from individuals served in inpatient and outpatient settings in Norway, Wales, and Denmark, respectively.

SMRs from studies on mortality in mental illness conducted in developed countries fluctuated between 2.3 (Krupchanka et al., 2018) and 4.9 (Heiberg et al., 2018) for schizophrenia, and 1.6 (Krupchanka et al., 2018) and 2.2 (John et al., 2018) for mood disorders. For all industrialized countries the mortality risk was higher for SMI groups than the comparison general population group (Charrel et al., 2015; Heiberg et al., 2018; John et al., 2018; Krupchanka et al., 2018; Lumme et al., 2016; Osby et al., 2016; Plana-Ripoll et al., 2019). Charrel et al. (2015) examined SMRs among individuals hospitalized for all psychiatric disorders and reported a disparately higher overall SMR of 3.9. Fekadu et al. (2015) examined the mortality risk in a SMI cohort in a no industrialized country and reported mortality risks of 3.0 for schizophrenia, 1.5 for bipolar, and 1.7 for depression, however the comparison was not made with the general population.

Generalization of findings may be problematic due to the method used to collect mortality and mental health data, also registries may differ in their purpose and in their inclusion and exclusion criteria, and in the data coding procedures. In addition, generalization of the findings may be constrained as the studies were conducted in different settings of care. It is then appropriate to understand the actual mortality risk of individuals with mental illness served in the PMHS under study. Findings may provide

information for decision making by administrators, clinicians, and client advocates at the local PMHS.

Mortality Surveillance in the U.S. PMHS

In the late 1990s and early 2000s, there was an interest from state mental health authorities in monitoring and understanding mortality risks in U.S. PMHS. Dembling, Chen, and Vachon (1999) reported nearly nine years lost due to premature death for individuals with SMI served in the PMHS than individuals in the Massachusetts general population. Wellins and Yang (2002) reported a 52% difference in crude mortality rate for persons served in the Nevada PMHS compared with the Nevada general population. Miller et al. (2006) reported SMR=3.2 and YPLL=32 years for patients with SMI served in the Ohio PMHS. Colton and Manderscheid (2006) explored the mortality risk among a multi-state (Arizona, Missouri, Oklahoma, Rhode Island, Texas, Utah, Vermont, & Virginia) sample of PMHSs. Although Colton and Manderscheid (2006) reported elevated mortality risk for patients served in the PMHSs compared with the mortality risk in the respective general populations, some shortcomings may prevent the application of the findings to the PMHS under study. For example, not all states provided data for all years, the matching procedure with death records was not standard across states, and the estimated YPLL was not weighted by the age-gender distribution in the states' general populations. The reported SMRs varied widely across states providing conflicting results. Some state showed an increasing mortality SMR trend, other states showed a decreasing trend, and for other states no change in the excess mortality was observed. Finally,

Colton and Manderscheid (2006) did not provide demographic information about the samples included in each state to compare with the decedents in the current study.

The Oregon Department of Human Services Addiction and Mental Health Division (2008) reported that individuals with mental disorders who were served in the Oregon PMHS died 4 years earlier than individuals in the Oregon general population. Researchers analyzed data for 226,787 decedents who received services for all types of mental disorders or substance use. The study also included individuals who were 15 years and older predominantly Whites and females.

Phelan and Ortiz (2013) reported SMRs that ranged from 1.7 to 2.2 in a sample of individuals with mental illness and substance use disorders served in the Missouri PMHS. The estimated YPLL in 2010 was 17 years more than what an individual in the Missouri general population would have lost.

Papas et al. (2015) found SMRs of 2.5-3.0 for Medicaid patients with SMI as Medicaid status has been used as a proxy for low income. Papas et al. (2015) explored characteristics related to the Delaware Medicaid system such as number of annual Medicaid claims, number of annual Medicaid emergency room claims, number of annual hospitalizations claims, and Medicaid billed amount for medical visits in a predominantly (73%) White sample.

Ortiz (2020) investigated the YPLL among a population group served for mental health and substance use disorders in the Michigan PMHS. Ortiz (2020) found that persons served in the Michigan PMHS (17.94) had on average greater YPLL than persons who were Medicaid eligible (17.08) or persons in the general population (13.00).

Findings from research in PMHSs provide significant information about the mortality risk experienced by population groups with mental illness but because of study designs that served a particular purpose for each state at a specific point in time, there were gaps that may be understudied and that could provide ground-breaking approaches to the problem. PMHSs continue to face mental healthcare reforms and state policy changes that may have an impact on mortality trends among the served population groups.

Mortality Surveillance of a Local PMHS

The local PMHS from which data were analyzed in the current study is an agency that coordinates community-based and inpatient mental health services. In 2018, the PMHS served more than 23,000 clients, of which 67% met the definition for SMI; 97% were served in community settings and 3% in an inpatient setting, and more than $250,000,000 was spent servicing this population group. About fifty-five percent of the population served by the staff from the PMHS under study was comprised of males, 91% were African-Americans, 83% were between 21 and 64 years, 5% were 65 and older, and 85% were unemployed or not in labor force (Substance Abuse and Mental Health Services Administration [SAMHSA], 2018). When the population group served in the PMHS under study was compared with the population groups included in similar mortality studies performed at the state level differences were observed. For example, studies conducted by Daumit et al. (2010), Piatt el al. (2010) and Sherman et al. (2013) included samples that were treated in community-based settings excluding individuals treated in inpatient settings. Studies from Miller et al. (2006), Papas et al. (2015), Phelan

and Ortiz (2013);, Ortiz (2020), Piatt el al. (2010) and Sherman et al. (2013) were mainly composed of decedents that were White, about 30% of decedents were 65 years and older. In Papas et al. (2015) study, data from only Medicaid clients were included for analysis.

The executive team from the PMHS under study provided mental and mortality longitudinal data from 2010 to 2014 to explore mortality risks among all individuals served by the system, regardless of the setting of care. I examined: the relationship between mental illness and excess and premature mortality, mental illness and risks of all- and specific-cause of death, and the relationship between distal, intermediate, and proximal factors and premature mortality. This information may be used to identify and prioritize policy, resources, and for health promotion. For example, after exploring the mortality status of individuals with mental illness, the Ohio Department of Mental Health required public mental health hospitals to implement tools for reducing heart disease developed by the American Heart Association (Miller et al., 2006). The staff at the PMHS under study could implement similar efforts. Findings from this study include demographic and epidemiological profiles of persons served in a PMHS who were more likely to experience excess and premature mortality. Identifying significant risk factors of early mortality may help in designing preventive efforts aimed at improving mortality rates.

Overview of Manuscripts

Framework

The proposed research was driven by the empirical data about the elevated risk of mortality faced by individuals with mental illness. The proposed studies were framed under a multi-level ecoepidemiological life course framework for health, disease and mortality. Figure 4 presents the adapted framework which links mechanism that influence health and longevity in space and time and recognizes multiple levels of causation (Defo, 2014). The distal level includes the environment which protect from or expose to health-related outcomes. The intermediate level includes factors that cause variation in the outcome and are themselves caused to vary by distal variables. It has been observed that individuals with mental illness have higher rates of tobacco use than individuals in the general population (Hartz et al., 2014). Thus, tobacco use may cause variation in mortality among the proposed study group. It has also been observed that the use of tobacco in mental health settings may be promoted as part of the therapeutic treatment for patients (Prochaska, Das, Young-Wolf, 2017).

The proximal level includes factors prevailing prior to the occurrence of the mortality. Proximal factors include demographic factors (age at death, gender and race) and socio-economic factor (educational level, Medicaid status, and marital status). The outcome level includes measures of population health and burden of disease (*SMR*, *YPLL*, and *OR*).

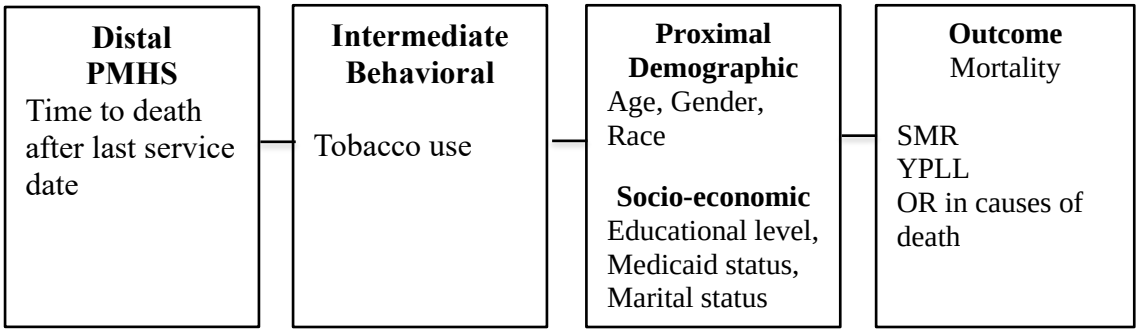

Figure 4. Adapted version of the ecoepidemiological life course framework for health, disease, and mortality. Developed by B. K. Defo Copyright 2014.

Colton and Manderscheid (2006) disclosed the social injustice encountered by population groups with mental illness served in PMHSs. Since then, multiple researchers at the state (Daumit et al., 2010; Miller et al., 2006; Papas et al., 2015; Piatt et al., 2010; Sherman et. al., 2013), national (Olfson et al., 2015), and international levels (Charrel et al., 2015; Fekadu et al., 2015; Heiberg et al., 2018; John et al., 2018; Krupchanka et al., 2018; Lesage et al., 2015; Lumme et al., 2016; Osby et al 2016; Plana-Ripoll et al., 2019) have continued monitoring the mortality indicators for individuals with mental illness. However, the application of the findings may be challenging.

The mortality risk was explored by examining the relationship between mental illness and excess mortality through the examination of SMR and YPLL in Manuscript 1. The SMR describes the amount of death in a population group. The YPLL requires age at death which allows the estimation of the average time an individual would have lived had that individual would have not died prematurely or before his or her natural time. The accumulation of the times lost in terms of years by population groups such as individuals

with mental illness may help in comprehending the impact of the social and economic loss this population group did not to contribute to society because their deaths were not prevented (Gardner & Sanborn, 1990).

Through Manuscript 2, SMRs, YPLLs, and ORs for all- and specific-cause of death were used to examine the differences in mortality risk. Proportional mortality (PM) was computed to understand the degree at which a specific cause of death contributes to total mortality among both individuals served in the PMHS (PM_{PMHS}) and individuals in the general population (PM_{GP}). If PM_{PMHS} for a specific cause of death was larger than PM_{GP} for the same cause of death, then the mental illness could be related to the increased mortality risk in the specific cause of death.

Through Manuscript 3, I identified significant predictors of premature mortality as measured by the YPLL. Findings of three studies may provide insights for the development of specific preventable initiatives that may decrease the mortality risk among the people with mental illness served in PMHSs.

Manuscript 1

Specific problem. The excess and premature mortality experienced by population groups with mental illness served by several PMHSs has been disclosed. However, demographic differences in the population groups served by these systems have been observed in comparison to the population group served in the PMHS under study. Therefore, the PMHS under study may be serving a population group that could be experiencing excess and premature mortality impacting the overall public health.

Research question. What is the relationship between mental illness and excess

mortality?

Nature of the study. The study was quantitative and involved an analysis of retrospective data for a cohort of individuals that died between January 1, 2010, and December 31, 2014.

Possible types and sources of data. The number of individuals served in the PMHS under study stratified by age, gender and race, and by study year (2010-2014) were provided by the PMHS. Death cases were provided by the Department of Health (DOH). The total population for the general population and death rates were collected from the Centers for Disease Control and Prevention (CDC) for the same study years. Death dates were collected from DOH death records.

Manuscript 2

Specific problem. There is no absolute agreement in the leading causes of deaths among individuals with mental illness that are served in PMHSs. This pose challenges for the identification of evidence-based practices that could have an impact on mortality.

Research question. What is the relationship between mental illness and the risk for all- and specific-cause of death?

Nature of the study. The study was quantitative and involved an analysis of retrospective data for a cohort of individuals that died between January 1, 2010, and December 31, 2014.

Sources of data. Death cases were provided by DOH. DOH also provided selected demographic extracts and causes of death from death certificates. Other demographic data were selected from the PMHS under study services database.

Manuscript 3

Specific problem. There is no estimation of the casual relationship between mental illness of those served by PMHSs and the predictive factors at the distal, intermediate, and proximal levels that are framed under an ecoepidemiological life course model that recognizes multiple levels of causation. This relationship may contribute to the development of initiatives that may reduce excess mortality among persons with mental illness who are served in PMHSs.

Research question. What is the predictive relationship between distal (time to death after last service date), intermediate (tobacco use), and proximal (gender, race, educational level, Medicaid status, and marital status) factors and premature mortality?

Nature of the study. The study was quantitative and involved an analysis of retrospective data for a cohort of individuals that died between January 1, 2010, and December 31, 2014.

Sources of data. The source of data included a patient-level matched data set with demographic, socioeconomic and behavioral factors, and death data. Data for individuals with mental illness who were served in a PMHS was provided by the PMHS. DOH provided mortality data.

Significance

The findings of three studies can be used to advance knowledge in public health. Public health leaders may increase their knowledge about the actual and projected mortality risk among persons with mental illness served in PMHSs which can be used to monitor progress of current initiatives. It can also be used to develop new initiatives that

could be more effective at improving comorbidities with mental illness. Public health leaders can also use the information to identify the leading needs of persons with mental illness to better targeting resources. Understanding the demographic and epidemiological profile of individuals served in the PMHS may contribute to the development of health policies aimed at reducing the risk of mortality. The completion of the three studies demonstrated that linkages of data from multiple databases at the local PMHS are possible and empirical evidence can be derived from them.

Summary

Individuals who are served in PMHSs experience unequal mortality risks compared to individuals in the general population (Kondo et al., 2017; Laursen et al., 2014). Increased mortality risks may be prevented by focusing on the causes of death and by identifying risk factors of premature mortality (Thacker et al., 2006). This study included data from a matched data set of mental health and death data for all persons that were served in a PMHS during 2010-2014. Through Manuscript 1, I estimated the excess and premature mortality as measured by the SMR and YPLL experienced by individuals served in the PMHS and compared it with the mortality risk in the general population. I also investigated the mortality relative risk associated to SMRs. I measured the strength of the association between study groups and YPLL. I also estimated how many more years an individual served in the PMHS lost due to premature mortality compared with an individual in the general population not served by the PMHS.

Through Manuscript 2, I estimated the proportional mortality rates for the leading causes of deaths by study groups. I also estimated the risk of mortality by examining the

SMR, YPLL, and ORs for all- and specific-cause of death. I explored the excess mortality (*SMR*) for individuals served in the PMHS by gender, race, and age. Finally, I investigated distal, intermediate, and proximal risk factors associated with premature mortality necessary for the delineation of preventative efforts through Manuscript 3. The manuscripts are presented next.

Part 2: Manuscripts

Manuscript 1

Examining the Mortality Risk of a Population with Mental Illness

Glorimar Ortiz

Outlet for Manuscript

Social Psychiatry and Psychiatric Epidemiology will be the target journal for the manuscript. The URL for the manuscript submission for this journal was: https://link.springer.com/journal/127. The journal's formatting expectations include that "the paper must be written in English; original papers must not exceed 4,500 words (not including references plus five tables or figures); and an abstract (150 to 250 words) that includes the Purpose, Methods, Results, and Conclusion must be submitted and 4-6 key words" (Springer Nature Switzerland, 2020). The title page must include: name(s) of the author(s), a concise and informative title, affiliations of author(s), and an active email address.

> Manuscripts are submitted in Word; written in a normal format and plain font (10-point, Times Roman); using italics for emphasis; and numbering the pages. Tab stops or other commands for indents should be used, not the space bar. Use the table function, not the spreadsheet, to make tables. Use the equation editor or Math Type for equations. Abbreviations should be defined at first mention and used consistently thereafter. Footnotes can be used to give additional information. Acknowledgements of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full. The list of references should only include works that are cited in the text and that have been published and accepted for publication. The entries in the reference list should be numbered consecutively. Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviation. All tables

are to be numbered using Arabic numerals. Tables should always be cited in text in consecutive numerical order. For each table, provide a table caption (title) explaining the components of the table. Identify any previously published material. Footnotes to tables should be indicated by superscript lower-case letters (or asterisk for significance values and other statistical data) and included beneath the table body.

The journal aligns with the content in the manuscript because its focus is to publish research related to all aspects of the epidemiology of psychiatric disorders. The journal also has history of publishing research related to mortality among population groups with mental illness.

Title Page

Relationship Between Mental Illness and Excess Mortality in the Public Mental Health System

Glorimar Ortiz, M.S.

Walden University

glorimar.ortiz@waldenu.edu

Abstract

Background: Mental illness is a factor for high mortality risk. Although estimation of both SMR and YPLL lead to different interpretations of the mortality problem, few studies have examined the risk using both approaches.

Purpose: The aim of this study was to estimate excess and premature mortality and odds of dying prematurely among mainly Black individuals who were served in a PMHS.

Methods: Service data from a PMHS were matched with death data from DOH from 2010 to 2014. SMRs and the respective relative risk (*RR*) were calculated to examine the excess mortality. YPLL were computed to determine premature mortality. Linear regression was used to project adjusted excess in years lost due to early mortality.

Results: Data from 1,234 decedents who were served in a PMHS showed that the overall SMR was 1.78 (95%, *CI*, 1.61-1.96). The RR was 30% higher than the risk for individuals in the general population. The mean YPLL was estimated at 23 years. Individuals served by the PMHS lost at least 5.49 more years than individuals in the general population due to early mortality.

Conclusion: Persons who were Black presented higher priority for mortality prevention and may require distinctive approaches to address the problem. Persons 45-64 years were at increased mortality risks, suggesting a mortality burden of at least 14 years.

Key words: *mental illness, public mental health system, SMR, YPLL*

Introduction

Researchers argue that mental illness is considered a risk factor for excess and premature mortality. In a meta-analysis of all mental disorders, Walker, McGee, and Druss (2015) estimated the relative risk of mortality at 2.22 (*95% CI*, 2.12-2.33). Oakley et al. (2018) argued that in a schizophrenia and psychotic disorders cohort the excess mortality was greater estimated at 3.08 (*95% CI*, 2.88-3.31). Hayes et al. (2015) reported a SMR = 2.05 (*95% CI*, 1.89-2.23) in a cohort of bipolar disorders. In a meta-review of multiple mental disorders, Chesney et al. (2014) said that the premature mortality represented 10 – 20 years reduction in life expectancy Colton and Manderscheid (2006), Kondo et al. (2017), Laursen, Nordentoft, and Mortensen (2014), and Lesage et al. (2015) confirmed previous findings and reported a reduced life expectancy of 10 – 25 years for persons with mental illness.

Findings from population-based samples also present evidence of the excess mortality risk. For example, among persons hospitalized for severe mental illness the excess morality was estimated at two- to three-fold greater mortality than persons in the general population (Krupchanka et al., 2018; Lumme et al., 2016; Osby et al., 2016). In a sample of persons hospitalized for all psychiatric disorders in a public psychiatric hospital, Charrel et al. (2015) reported elevated excess mortality (*SMR* = 3.89). Plana-Ripoll et al. (2019) and John et al. (2018) included data from individuals served in inpatient and outpatient settings to offset the observed greater mortality risk in inpatient samples and reported SMRs of 2.53 and 2.60, respectively. Heiberg et al. (2018) demonstrated the higher excess mortality in a schizophrenia cohort treated in specialized

healthcare settings (*SMR* = 4.4). Regardless of the study design, findings provide an overview of the excess and premature mortality. However, the application of the findings to different settings of care may be challenging due to the inherent heterogeneity of previous studies.

SMRs have been reported for samples of individuals with mental illness served in the PMHS that range from 1.2 (Colton & Manderscheid, 2006), 1.9 (Phelan & Ortiz, 2013), 3.2 (Miller et al., 2006), 3.7 (Daumit et al., 2010), and 5.9 (Sherman et al., 2013). Premature mortality was also reported by Colton and Manderscheid (2006) (average *YPLL* = 25), Miller et al. (2006) (average *YPLL* = 32), and Piatt et al. (2010) (average *YPLL* = 14.5). Findings on excess and premature mortality increased the specificity among individuals with mental illness served in U.S. PHMSs. While excess and premature mortality among individuals with mental illness is unwanted, the findings may suggest that it is a persistent problem.

Surveillance of mortality among people with mental illness reflects discrepancies in the methodology used (e.g., type of populations under study, ascertainment of mortality status, reporting of the outcome) that may account for the disparities in the SMRs and YPLL reported thus limiting the usefulness of the findings when the intent is to implement preventative measures in a specific PMHS. Some studies focused on specific mental disorders such as schizophrenia, others included only inpatient or outpatient populations or both. To evaluate the mortality status or the excess and premature mortality, some studies reported SMRs and RR statistics, others reported YPLL, others used average age at death and others used a combination of these.

For the current study, matched mental health data and death data were provided by a PMHS that coordinates community-based and inpatient mental health treatment services. The population group served by the PMHS under study has presented demographic variations when compared with other PMHSs. The most critical cases include that 91% of the individuals served in the PMHS under study are African-American, only 5% are older people of 65 years and older, and it has the highest rate at which individuals with mental illness that are involved with the criminal justice system are admitted to inpatient psychiatric care compared with other PMHSs in the U.S. (Department of Health, n.d.; Wik, Hollen, & Fisher, 2017).

Therefore, the main purpose of this study was to examine the relationship between mental illness and excess mortality for a cohort of individuals served in a PMHS in both community-based and inpatient settings and compare it with the general population. The excess mortality was examined using two approaches to determine the: ratio between observed and expected deaths (*SMR*), and the surplus of years lost (*YPLL*). The specific objectives of the study were to: estimate the SMRs and 95% confidence intervals and the mortality relative risk (*RR*) for decedents served in the PMHS by gender, race, and age group; estimate the mean YPLL for decedents served in the PMHS by gender and race; and, estimate the magnitude of the mean YPLL of individuals served by the PMHS adjusted by gender and by race. I hypothesized that there were statistically significant differences in the mortality risk between individuals served in the PMHS and individuals in the general population.

Significance

This information may be used to identify and prioritize policy, resources, and for health promotion. It may also provide insights for treatment modification and to implement evidence-based practices.

Relevant Scholarship

It is known that individuals served in PMHSs experience excess mortality compared to individuals in the general population. While excess mortality has been mainly calculated by assessing the ratio between the observed and expected number of deaths, no study has applied predictive techniques to this relationship. Although the estimation of both SMR and YPLL provide different interpretations of excess and premature mortality, few studies have examined the risk applying both techniques. What needed to be investigated about the risk of mortality was the projection of how many more years were expected to be lost by individuals with mental illness served in a PMHS by gender and by race.

Research Questions and Design

1. What are differences in terms of SMRs between individuals served in a PMHS and individuals in the general population?

2. What is the estimated mortality relative risk (*RR)* for individuals served in a PMHS compared with individuals in the general population?

3. What are mean differences in YPLL scores for individuals served in a PMHS by gender and race?

4. What is the magnitude of YPLL scores for individuals served in a PMHS when adjusted for gender and race?

The study was quantitative and involved an analysis of retrospective data for a cohort of individuals who died between January 1, 2010, and December 31, 2014.

Methods

Target Population

The study included all persons who received mental health services from the PMHS between January 1, 2010, and December 31, 2014, and that were matched with death records. The comparison group included all decedents in the general population during the study periods who were not served by the PMHS under study.

Sample and Power

The study sample included all adults 18 years and older who received mental health services and died during the study period. More than 22,000 death records were received for the five-year study period. To estimate the mean YPLL differences for individuals served in the PMHS under study by gender and race, a t-test was used. For an effect size of 0.5, an alpha error of 0.05, and a power of 0.95, 105 cases were needed in each independent group (gender or race). For the bivariate correlation to estimate the association between the study groups and YPLL, Point biserial, which is equivalent to Pearson's *r*, was used. For an effect size of 0.3, an alpha error of 0.05, and a power of 0.95, 134 cases were needed. Linear bivariate regression to estimate the adjusted YPLL for two groups was used. For a two-tailed test, an alpha error of 0.05, and a power of 0.95, 119 cases were needed in each group.

Procedure

Data for this study were derived from death records and mental health service data. Death records were obtained from DOH for 2010-2014. The matching procedure utilized death data from the state Vital Statistics System (VSS). Death data from VSS are preferred because they provide demographic, geographic, behavioral, and cause of death information for all individuals that died in the state (Centers for Disease Control and Prevention [CDC], 2019a). VSS is also considered the primary standardized source of health-related data (CDC, 1989).

Mental health data were obtained from the database from the PMHS under study. Death records were matched with the individuals who received mental health services from the PMHS under study between January 1, 2010, and December 31, 2014. Decedents younger than 18 years were excluded from the study. Individuals that were matched were considered cases and were part of the PMHS served group and the unmatched were part of the general population group. The case matching procedure used a two-search process. The procedure for Search 1 was comprised of three combinations of social security number (SSN), first name, last name, gender, and date of birth. Search 2 was used if Search 1 did not produce any case match and included one combination of last name, first name, date of birth, and gender. If a person received multiple services during the study period, the most recent data from the identified primary data source was abstracted. For the data collected from the PMHS mental health service database, the most recent assessment was used. If the recent assessment or updated data were not

available, the data collected at the time of admission were used. Data admission that was older than 12 months were not extracted.

Variables and Sources of Data

Dependent variables. Dependent variables for the study include two mortality indicators: SMR and YPLL. SMR compares the observed number of deaths with the expected number of deaths by applying the general population gender- and age-specific deaths rates (Curtin & Klein, 1995). SMR describes the amount of death in a population (Gardner & Sanborn, 1990). The RR associated with each SMR was also calculated as it provides an idea of the likelihood of mortality based on some exposure, in this case, being served in the PMHS for mental health services. The YPLL represents the social and economic burden (Gardner & Sanborn, 1990). YPLL indicates the average number of years a person (gender- and age-specific) would have lived had she/he had not died prematurely based on an estimated life expectancy. Gender- and age-specific life expectancies were collected from life tables for each study year generated by the Centers for Disease Control and Prevention (CDC) and were used to subtract the age at death for each individual to obtain the YPLL (Arias, 2014; Arias, 2015; Arias, Heron, & Xu, 2016; Arias et al., 2017; Arias et al., 2018). For example, if a male decedent with mental illness served by the PMHS died in 2010 at the age of 45 years and the life expectancy according to the CDC life tables was 65 years, then the YPLL was 20 years.

Table 1

Operational Measures for Dependent Variables

Mortality indicator	Numeric expression	Sources of data
SMR	Numerator: observed number of deaths	CDC Wonder system for death rates
	Denominator: expected number of deaths	PMHS service data for the persons served by the PMHS
	$SMR=\Sigma(O/E)ij$ i=age group j=gender type	
YPLL	YPLL=[Life expectancy – average death age]ij	CDC Life expectancy tables
		DOH death records

Note. SMR = standardized mortality ratio; YPLL = years of potential life lost; PMHS = public mental health system; DOH = Department of Health.

Independent variables. Independent variables included the variables that were used to describe the sample under study. Demographic characteristics (age at death, gender, and race), and socio-economic factors (educational level and marital status) were retrieved from death certificates. Because 75% of the employment data were missing, this variable was dropped from data analyses. Type of service, the last date of service, and Medicaid status were collected from the PMHS service data system. The last date of service was used to compute the time to death after the last service date. Because only the month and the year of death were submitted, when calculating time to death, it was assumed that individuals died on the first day of a given month. For the bivariate correlation, the independent variables were study group (individuals served by a PMHS or general population), gender, and race.

Design and Analysis

The design of the study involved a retrospective secondary analysis of cohort data. Descriptive analysis was performed to demographically describe the sample under study. Chi-square was used to test significant differences between decedents served in the PMHS under study and decedents in the general population and the demographic characteristics. To examine excess mortality, first, SMRs were calculated using the observed and expected number of deaths. The expected number of deaths for the PMHS served group was computed by multiplying the total population served by the PMHS under study in each study year by the general population death rate in the same year. Age-, gender-, and race-specific death rates were applied accordingly. Expected number of deaths for the general population was computed using population projections from the U.S. Census Bureau for each study year and by age, gender, and race. The 95% confidence intervals were computed using contingency tables and exponentiating the natural log of the risk ratio associated with the SMR. The difference in risk was computed by subtracting the SMR from those exposed or served by the PMHS from the SMR from the not exposed or people in the general population. The mortality RR was computed using contingency tables and represents the probability of death among the exposed compared to the probability of death among the not exposed.

Second, excess mortality was examined by estimating the surplus in years lost due to premature mortality by calculating YPLL. Because the population served by the PMHS under study had different age and gender distributions compared to the general population, age and gender adjustments were performed before the computation of

YPLL. The direct standardization procedure recommended by the CDC was used and a weight was computed. The formula for the computation of the weight was $W = P_{GP}/P_{PMHS\ served}$, where W was the final analysis weight for each case by age and gender; P_{GP} was the proportion of the general population for each age and gender; $P_{PMHS\ served}$ was the proportion of the total PMHS served population for each age and gender. If the PMHS under study served a higher proportion of persons in a specific age group than the proportion of persons in the same age group in the general population, then a weight less than 1 was applied. Otherwise, a weight greater than 1 was applied. Differences in mean YPLL by gender and race in each study year were tested using a t-test. Linear regression was used to estimate the adjusted projected magnitude of the excess mortality as measured by YPLL. Statistical analyses were performed on SPSS version 26 and the significance level was set at $p < .05$, two-tailed. Standardized mortality ratios and the 95% confidence intervals were computed using contingency tables. When confidence intervals excluded 1.0, the SMR was considered statistically significant.

Results

Execution

The data set provided by the PMHS under study contained most of the information requested and needed to perform all proposed analyses. However, only between-group comparisons were possible as the information about the psychiatric diagnosis needed to classify decedents as SMI versus no SMI was not provided. Therefore, within-group comparisons were not conducted. It is of general knowledge that

the majority of the individuals served in the PMHS under study are considered to have SMI. Employment status was dropped from analysis as 75% of the data were missing.

Descriptive analysis. Data for a total of 22,668 adults 18 years and older who died from 2010 to 2014 were analyzed. Five percent of decedents were served in the PMHS under study. Table 2 presents the demographic characteristics of the sample by study group. The group of individuals served in the PMHS under study was significantly different from individuals in the general population in the majority of the demographic characteristics such as gender, race, marital status, and age at death. A greater proportion of decedents served in the PMHS under study were males (55%) ((x^2=1, 22,665) = 633.84, p=.000); Black (88%) ((x^2=1, 22,149) = 102.80, p=.000); and not married (81%) ((x^2=1, 22,066) = 70.21, p=.000). Decedents served in the PMHS under study died younger (t(23,255)=-22.91, p=.000) and lost seven more years due to premature mortality than decedents in the general population (t(23,197)=-23.65, p=.000). Persons served in the PMHS died on average within 232 days after the last service date and 84% received Medicaid benefits.

Table 2

Characteristics of Decedents Between 2010 and 2014

	All decedents *N*=22,668 (%)	Decedents served by the PMHS *n*=1,234 (%)	Decedents in the general population *n*=21,434 (%)	*p* value
Gender				
Male	5,694 (25)	683 (55)	5,011 (23)	.000
Female	16,971 (75)	551 (45)	16,420 (77)	
Missing	3 (0)	0 (0)	3 (0)	
Race				
Whites	4,721 (21)	117 (9)	4,604 (21)	.000
Blacks	17,428 (77)	1,090 (88)	16,338 (76)	
Other races/DK	519 (2)	27 (3)	492 (3)	
Age Groups				
18-24 years	297 (1)	40 (3)	257 (1)	.000
25-44 years	1,340 (6)	162 (13)	1,178 (6)	
45-64 years	6,167 (27)	801 (65)	5,366 (25)	
≥65 years	14,864 (66)	231 (19)	14,633 (68)	
Education				
<high school	5,491 (24)	308 (25)	5,183 (24)	.116
> high school	16,327 (72)	827 (67)	15,550 (73)	
Missing	850 (4)	99 (8)	751 (3)	
Marital Status				
Married	5,314 (23)	160 (13)	5,154 (24)	.000
Not married	16,752 (74)	997 (81)	15,755 (74)	
Missing	602 (3)	77 (6)	525 (2)	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	
Age at death	71.1 (17.4)	54.5 (12.9)	72.1 (17.1)	.000
YPLL	16.7 (12.3)	23.3 (11.7)	16.2 (12.2)	.000

Inferential analysis. The relationship between mental illness and excess mortality was tested examining statistical differences in SMRs and YPLLs among study groups. Table 3 shows that overall individuals served in the PMHS under study

experienced excess mortality estimated at 1.78 (95% *CI*, 1.61-1.96) compared with their counterparts in the general population. This excess mortality represents a 30% increased mortality RR than the risk in the general population. Greater SMRs were found for specific demographic characteristics. Table 4 shows that from the overall people served in the PMHS under study, females had significantly higher YPLL scores than males, and Blacks had significantly higher YPLL scores than Whites. Point biserial correlation showed that the study group was significantly correlated with YPLL (r (23,199) =.15, p=.000).

The screening for the assumptions of the linear regression showed that the data did not violate the requirements for testing. The unadjusted linear regression produced the following predictive formula: YPLL = 16.16 + 7.12 (Study group) (F (1, 23,198) = 559.53, p = .000) (R^2=.02), where study group was coded as 0 = general population and as 1= PMHS. Table 5 contains the results of the weighted or adjusted multiple linear regression to determine the magnitude of YPLL score. After adjusting the predictive formula by decedents' gender and race, individuals served in the PMHS under study lost 5.49 more years due to premature mortality than individuals in the general population (F (3, 22,661) = 534.91, p = .000). Males served in the PMHS under study lost 4.28 more years compared to females, and individuals who were Black lost 3.63 more years than White individuals due to premature mortality. Due to the high multicollinearity between age at death and YPLL, age was not included in the adjusted regression model.

Table 3

SMR and Mortality RR for Decedents

	Decedents served by the PMHS *n*=1,234 *SMR* (95% *CI)*	Decedents in the general population *n*=21,434 *SMR* (95% *CI)*	PMHS-GP SMR diff	PMHS-GP RR
Overall	1.78 (1.61-1.96)	1.42 (1.38-1.46)	0.36	1.3
Gender				
Males	1.85 (1.62-2.11)	0.68 (0.65-0.72)	1.17	2.4
Females	1.70 (1.48-1.96)	2.12 (2.04-2.20)	-0.42	0.8
Race				
Whites	8.36 (4.79-14.57)	1.09 (1.03-1.15)	7.34	6.7
Blacks	1.67 (1.51-1.84)	1.14 (1.10-1.17)	0.53	1.2
Age Group				
18-24 years	3.33 (1.71-6.49)	0.85 (0.67-1.07)	2.48	3.3
25-44 years	3.06 (2.21-4.22)	1.18 (1.05-1.33)	1.88	2.4
45-64 years	3.13 (2.70-3.62)	1.10 (1.04-1.16)	2.03	2.6
≥65 years	1.53 (1.24-1.88)	1.07 (1.04-1.11)	0.46	2.0

Table 4

Weighted YPLL Mean Difference for Persons Served in the PMHS by Gender by Race

	Overall *N*=1,234	2010 *n*=175	2011 *n*=214	2012 *n*=219	2013 *n*=283	2014 *n*=343
PMHS	23.28	23.47	22.78	23.34	23.28	23.49
Gender						
Males	22.54	21.79	21.96	22.47	22.72	23.22
Females	24.14	25.61	23.67	24.28	23.91	23.82
Diff $_{\text{Male:Female}}$	-1.59	-3.82	-1.70	-1.81	-1.19	-0.60
95% *CI*	-2.68	-6.71	-4.33	-4.24	-3.41	-2.81
Diff $_{\text{Male:Female}}$	-0.50	-0.92	0.92	0.63	1.04	1.61
Significance Diff $_{\text{Male:Female}}$	.004	.010	.202	.146	.296	.593
Race						
Whites	17.81	17.81	16.95	14.63	18.58	19.09
Blacks	24.26	24.92	23.74	24.11	23.90	24.53
Diff $_{\text{White:Black}}$	-6.33	-7.11	-6.79	-9.48	-5.32	-5.44
95% *CI*	-7.96	-10.59	-10.85	-14.26	-8.65	-8.73
Diff $_{\text{White:Black}}$	-4.71	-3.63	-2.72	-4.69	-1.99	-2.15
Significance Diff $_{\text{White:Black}}$	.000	.000	.001	.000	.002	.001

Table 5

Magnitude of YPLL Score Adjusted by Gender and Race

	β	95% *CI*		*p* value
		LL	*UL*	
Constant	12.33	11.99	12.68	.000
PMHS-served	5.49	4.49	5.66	.000
Gender-Male	4.28	3.78	4.51	.000
Race-Black	3.63	3.28	4.05	.000
R^2 = .06				
R^2_{adj} = .06				
R = .26				

Note. PMHS = public mental health system; β = beta coefficient; *CI* = confidence interval; LL = lower level; UL = upper level. *R* = correlation coefficient; R^2 = coefficient of determination; R^2 adj = R^2 adjusted. Reference group Gender = female; Race = White.

Discussion

Interpretation

The main purpose of this study was to examine the relationship between mental illness and excess mortality in the PMHS. PMHS, from which death data were analyzed, served mainly individuals with SMI (70%) who received Medicaid benefits (84%) in primarily community settings (97%). It was found that individuals served in the PMHS under study significantly experienced excess in the observed:expected death ratio and premature mortality as measured by the YPLL. In terms of the observed:expected death ratio, the overall SMR was 1.78 for the individuals served in the PMHS under study representing a statistically significant greater mortality RR of 30% in comparison with

the general population. The mortality RR for the PMHS served group more than doubled for males (2.4) and for persons who were 25-64 years (2.4-2.6), and more than tripled for persons between 18 and 24 years (3.3). Decedents who were White experienced a disparately increased likelihood of mortality (6.7). This outcome warrants further interpretation. Only 9% of all deaths among people served in the PMHS were attributed to people who were White. In general, White people in the general population tend to have lower death rates than Black people. The expected number of deaths for decedents who were White and were served in the PMHS represented only 12% that of the observed number of deaths. The expected number of deaths for decedents who were Black and served in the PMHS represented 60% that of the observed number of deaths. This difference produced a higher SMR for the decedents who were Whites. In general, individuals served in the PMHS under study could experience a seven-times greater excess mortality rate than individuals in the general population (*SMR* difference=7.34).

It was also found that female decedents served in the PMHS experienced no significant difference in mortality RR (0.8). While the overall SMR finding of 1.78 was lower than what has been reported, the SMRs for the stratified demographic characteristics such as age (3.06-3.33) align with other published outcomes. Kondo et al. (2017) found an overall SMR = 3.28 among people with severe mental illness served in a community-based mental health setting in Japan, which is the world leader in longevity. Kondo et al. (2017) also found gender-specific SMRs that were elevated compared to current findings. While Kondo et al. (2017) presented inferior mortality metrics compared to the current study, only 45 deaths were included from a small, single study

setting. Overall findings for the PMHS under study were also lower than previous findings from other U.S. PMHSs. Daumit et al. (2010) analyzed community-based data from the Maryland Medicaid system and found an excess mortality of 3.7 in a primarily Black sample (51%). However, decedents served in the Maryland Medicaid system who were White and younger than 35 years were at higher mortality risk. As opposed to the current study, females in the Maryland Medicaid system were at higher mortality risk compared to males. Forty-five percent of decedents in the PMHS under study were females, they had similar age at death (55 years) as males (54 years) and accounted for only a 15% difference in the observed SMRs, with an RR at almost two times fewer than that of males. Differences in the findings by gender could be attributed to the proportion of deceased people in the age groups. Daumit et al. (2010) included decedents who were up to 64 years old while for the current study while I included individuals beyond 65 years old. Females in the current study accounted for 67% in the 65 years and older group suggesting that excluding persons in this age group could explain the higher mortality risk observed by Daumit et al. (2010).

Sherman et al. (2013) also analyzed matched service-mortality data from the Ohio PMHS and found greater mortality risk for those served by the system than those in the Ohio general population. Sherman et al. (2013) found that the excess mortality was experienced mainly by White males ((*SMR*=2.1, 95% *CI* (2.1-2.2)). However, the risk experienced by the decedents served in the PMHS under study was even higher. This risk could be attributed to demographic differences in the population served by the system. As opposed to the current study, 13% more individuals in the 65 and older age group were

served in the Ohio PMHS, more females (51%), and more persons who were White (82%). Nevertheless, the elevated risk experienced by persons with mental illness could suggest that a mental health condition may predominate as a mortality risk factor compared to demographic characteristics.

In terms of premature mortality, persons served in the PMHS under study died significantly younger (54.5 years) than individuals in the general population (72.1 years). This align with the 63% of decedents who were served by the PMHS under study who reached less than 65 years while 68% of decedents in the general population surpassed 64 years. The weighted unadjusted YPLL suggests that persons served in the PMHS under study could lose 23 years due to premature death, seven years more than a person in the general population. When adjusting the predictive formula by age and race, persons served in the PMHS could lose between 18 and 26 years due to early mortality. This loss is consistent with similar studies. Kondo et al. (2017) estimated YPLL at 22 years. Laursen et al. (2014) estimated a life expectancy of 10 and 25 years shorter for people with schizophrenia than for people in the general population. In terms of life expectancy, the individuals served in the PMHS under study experienced an observed life expectancy of almost seven years shorter than the general population which is lower than what has been observed. Phelan and Ortiz (2013) and Ortiz (2020) applied methods with minor variations to the current study, except that the samples mainly included data from White decedents, and reported an average YPLL of 30 years in a sample served in the Missouri PMHS and an average YPLL of 18 years for a sample served in the Michigan PMHS. In an Ohio study, Piatt et al. (2010) found that adults 18 years and older served in the PMHS

lost 14 years due to premature mortality. The decrease represents between 4 and 12 years fewer than individuals served in the PMHS under study (18-26 weighted years). The difference could be attributed to: the exclusion by Piatt et al. (2010) of individuals with dementia and substance use disorders who tend to have higher mortality rates, and to the comparison level, which was data from decedents in the city of Akron rather than the overall Ohio general population.

Limitations

The main limitation of the study deals with external validity. The study included decedents served in a PMHS with a high proportion of Black persons therefore generalization to other mental health settings may be limited. However, the findings are of great value as data analyzed were from an understudied population group. The sample under study is already at higher risk due to the level of severity and impairment and the inclusion of individuals with dementia who carry a greater mortality share. If they would have been excluded from the analysis, this may have affected current findings. Decedents served in the PMHS under the study who were White represented only 9% of all deaths that may have affected the significance of the SMR calculation as evidenced by the ample confidence interval. Caution is advised when interpreting and applying the findings into current practice. The analysis by SMI was not possible, thus limiting the specificity of the findings. Data used for analysis were extracted from death records and services databases, therefore errors during the matching procedure are assumed to be marginal.

Implications

There are several implications of the findings. Unique to this study is that two techniques were used to measure the relationship between mental illness and excess mortality: SMR and YPLL. SMR describes the number of deaths and its associated RR evaluates the risk that mortality has in the exposed group (decedents served in the PMHS) compared with the group that was not exposed (decedents in the general population). For example, persons served in the PMHS under study who were Black experienced 1.7 times excess mortality than persons in the general population, which represents a 20% (*RR*) greater mortality risk. Therefore, changing the number of deaths will likely change the reported statistics. The ratio of the observed and expected deaths (*SMR*) showed that excess mortality varies by demographic characteristics. When the RR associated with the SMR was examined, the risk of mortality more than doubled for individuals served in the PMHS who were males and between 24 and 64 years, and more than tripled for individuals younger than 25 years. Decedents who were White experienced an exponential disparity in the SMR. The finding merits careful consideration since only 9% of decedents in the PMHS under study were White, which translated into a wider confidence interval suggesting less certainty of the outcome. Findings provide empirical evidence for the PMHS to prioritize action to target groups at the highest need. Overall, the risk of death was increased among persons served in the PMHS under study than for persons in the general population.

The sample under study demographically differed from other samples treated in PMHSs as it was composed of mainly Black decedents. It was found that decedents who

were Black and served in the PMHS (*SMR*=1.67) experienced a slightly decreased excess mortality than the overall served in the PMHS (*SMR*=1.78) although it was still higher than Blacks in the general population (*SMR*=1.14). Being a White client of the PMHS (*SMR*=8.36) may pose a precarious mortality RR suggesting that they may die at a disproportionate rate compared to Blacks despite being served in lower numbers. The conflicting mortality metrics presented by persons who were White may be attributed to an artifact of the SMR calculation, which depends on the number of people served, the number of observed deaths, and the death rate in the general population from which expected deaths are derived. All these statistics were lower for Whites than for Blacks. The wide SMR confidence interval for Whites may be indicative of a less significant finding. Less than 10% of the persons that were served in the PMHS who died were White. Of the 1,234 observed deaths in the PMHS in the five-year period, more than 1,000 were from Black persons. Therefore, mortality among Black persons served in the PMHS under study is a critical problem. Research in the U.S. general population may provide insights into this problem suggesting that Black people tend to die of chronic diseases, such as cardiovascular disease, which are the number one causes of death possibly affecting the death rate. An understanding of the causes of death among persons served in the PMHS under study by race warrant consideration and may provide direction on how to reduce excessive deaths.

Persons served by the PMHS under study between 45-64 years (*SMR*=3.13) present the highest priority for mortality prevention. Persons who were 25-44 years old (*SMR*=3.06) may also deserve importance, however, they represent only 13% of all the

people served by the PMHS. Even though people who were 18-24 had the highest excess mortality (*SMR*=3.33), this group only represented 3% (n=40) of all decedents served in the PMHS under study thus wider SMR confidence interval. Decedents who were 45-64 years represented 65% of all deaths from the PMHS under study in the five-year period. This group may be contributing socially and economically to their families, their communities, and the overall society. However, individuals with mental illness would likely be unemployed (Miller et al., 2006), low educated and with low or no income (Daumit et al., 2010; Papas et al., 2015), facing unstable housing (Shan & Sandler, 2016), and abusing tobacco and other substances (Tofdahl, Nordentoft, & Hjorthoj, 2016). Therefore, it is important not only to understand the main causes of death for this age group but also how the social determinants of health impact the mortality risk among this population group. Sixty-seven percent of the PMHS decedents completed high school or a higher degree. It would be interesting to identify how many of decedents were employed at the time of death. A lower percentage may be indicative of the pervasive effect on mental illness.

In terms of premature mortality, the mean weighted YPLL for people served by the PMHS was estimated at 23 years. The mean weighted YPLL for males (22.5 years) was slightly lower than for females (24 years) suggesting that gender may not have a significant influence on premature mortality. However, similar to the SMR, race seems to play an important role. Adjusting for the effect of race is important because YPLL is not influenced by the death event merely removing any artifact due to a decreased denominator. Blacks (24 years) who were served in the PMHS under study significantly

lost more than six years due to premature mortality than Whites (18 years). Therefore, not only a greater number of deaths were attributed to decedents who were Black but they also lost more natural years. The adjusted regression line projected that an individual served by the PMHS under study may lose close to 18 years. If the individual served is a male, he is expected to lose up to 22 years (12.33+5.49+4.28), if Black up to 21.5 years (12.33+5.49+3.63), and if he is a Black male over 25 years (12.33+5.49+4.28+3.63). These elevated figures suggest the evaluation of current services provided to this population group and the development or adaption of intervention(s) embedded within the treatment for mental illness.

Recommendations

A fundamental next step is to understand the causes of death for individuals served in the PMHS under study. This search will help put in context the current findings. It is also important to identify the impact that removing individuals with dementia would have in the SMRs and YPLL. It was found that of the people that died from dementia, 70% were Blacks. A higher proportion (84%) of decedents were Medicaid beneficiaries, a proxy for low income. Isolating mental illness status from Medicaid status will also provide insights into the crude effect of mental illness on mortality. The adjusted equation from multiple linear regression explained only 6% of the variance in YPLL suggesting that other factors play a supplementary role. Therefore, understanding the influence of factors such as behavioral and clinical factors may elucidate a better understanding of excess and premature mortality. Finally, future analysis may provide

specificity of the problem by severe mental disorder (i.e., schizophrenia, major depression, or bipolar disorder).

Conclusion

Individuals with mental illness served mainly in community-based settings within a PMHS experienced increased excess and premature mortality compared with individuals in the general population. In a predominately understudied sample, individuals who were Black presented a higher priority for mortality prevention because they experienced lower life expectancy. This require innovative approaches to the excess and premature mortality. Of all age groups, persons who were 45-64 years were at an increased mortality risk, likely shortening their life expectancy by at least 14 years.

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Examining the Mortality Risk of a Population with Mental Illness

Manuscript 2

Glorimar Ortiz

Outlet for Manuscript

Social Psychiatry and Psychiatric Epidemiology will be the target journal for the manuscript. The URL for the manuscript submission for this journal was: https://link.springer.com/journal/127. The journal's formatting expectations include that "the paper must be written in English; original papers must not exceed 4,500 words (not including references plus five tables or figures); and an abstract (150 to 250 words) that includes the Purpose, Methods, Results, and Conclusion must be submitted and 4-6 key words" (Springer Nature Switzerland, 2020). The title page must include: name(s) of the author(s), a concise and informative title, affiliations of author(s), and an active email address.

> Manuscripts are submitted in Word; written in a normal format and plain font (10-point, Times Roman); using italics for emphasis; and numbering the pages. Tab stops or other commands for indents should be used, not the space bar. Use the table function, not the spreadsheet, to make tables. Use the equation editor or Math Type for equations. Abbreviations should be defined at first mention and used consistently thereafter. Footnotes can be used to give additional information. Acknowledgements of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full. The list of references should only include works that are cited in the text and that have been published and accepted for publication. The entries in the reference list should be numbered consecutively. Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviation. All tables

> are to be numbered using Arabic numerals. Tables should always be cited in text in consecutive numerical order. For each table, provide a table caption (title) explaining the components of the table. Identify any previously published material. Footnotes to tables should be indicated by superscript lower-case letters (or asterisk for significance values and other statistical data) and included beneath the table body.

The journal aligns with the content in the manuscript because its focus is to publish research related to all aspects of the epidemiology of psychiatric disorders. The journal also has history of publishing research related to mortality among population groups with mental illness.

Title Page

Relationship Between Mental Illness and Risk for All- and Specific-Cause of Deaths in the Public Mental Health System

Glorimar Ortiz, M.S.

Walden University

glorimar.ortiz@waldenu.edu

Abstract

Background: Persons with mental illness experience excess and premature mortality. The relationship between mental illness and the causes of death is contradictory posing challenges to the practice of care at the local level.

Purpose: The aim of this study was to estimate the excess and premature mortality for the causes of death of a primarily Black sample who was served in a public mental health system (PMHS).

Methods: Data from death certificates were matched with services data from the PMHS from 2010 to 2014. Standardized mortality ratios (*SMRs*) were used to examine the excess mortality. Years of potential life lost (*YPLL*) were used to examine premature mortality. Binary logistic regression was used to determine the odds ratio (*OR*) of dying prematurely associated with mental illness.

Results: The excess mortality due to unnatural causes by accidents was associated with mental illness estimated at nearly three-fold (*SMR*=2.97) greater excess mortality. People served in the PMHS under study lost 7.3 more years due to their mental illness than people in the general population. The OR was significantly higher for accidents (*OR*=2.46), mainly by drug overdose.

Conclusion: Individuals served in the PMHS may be at greater mortality risk due to unnatural causes of deaths mostly by accidents. Efforts may be focused at preventing drug overdose which are part of the elevated mortality risk by accidents among persons with mental illness served in a PMHS.

Key words: *mental illness, causes of death, SMR, YPLL*

Introduction

The mortality risk among individuals with mental illness is higher than for individuals in the general population. Walker et al. (2015) found that decedents with all types of mental disorders experienced two-fold (2.22, *95% CI*, 2.12-2.33) mortality relative risk than decedents in the general population. Oakley et al. (2018) found greater excess mortality in a schizophrenia and psychotic disorders cohort estimated at SMR = 3.08 (*95% CI*, 2.88-3.31). Hayes et al. (2015) reported a SMR = 2.05 (*95% CI*, 1.89-2.23) for a cohort of bipolar disorders. It has been estimated that people suffering from mental disorders may be at an increased risk of dying 10 - 25 years earlier than people without these disorders (Chesney et al., 2014; Colton & Manderscheid, 2006; Kondo et al., 2017; Laursen et al., 2014; Lesage et al., 2015).

Findings for the causes of deaths among individuals with mental illness are inconsistent. A natural cause of death is defined as a death due to illness or chronic disease or due to the natural aging process. An unnatural cause of death occurs from an external cause such as intentional (e.g., assault or suicide) or unintentional injury (e.g., accident). Hallgren, Osby, Westman, and Gisser (2019) reported a high suicide rate in schizophrenia (77%), bipolar (82%), and major depression (86%) groups. In a meta-review, Chesney et al. (2014) found unnatural deaths by suicide at more than 10-fold for individuals with schizophrenia (*SMR* = 12.9), bipolar disorder (*SMR*=17.1), or major depression (*SMR* = 19.7). In a register-based cohort that included people with schizophrenia, bipolar disorder, and major depression, Ribe et al. (2014) reported higher

cause-specific mortality risk ratios for unnatural causes of death, distinctly higher for suicide ranging from 12.2 and 20.5.

Findings were replicated in research studies conducted with specific cohorts of schizophrenia, bipolar disorder, and major depression. In a schizophrenia cohort treated in an inpatient setting, Ko et al. (2018) presented an elevated mortality risk by suicide (*SMR* = 31.3). Melle et al. (2017) found even greater mortality risk for suicide (*SMR* = 46.5) among a prospective cohort receiving first treatment for schizophrenia. Heiberg et al. (2018) also found higher SMRs for unnatural causes of death by suicide that ranged from 11.6 - 19.0 in a schizophrenia cohort that received mental health services in a specialized healthcare system. Comparable suicide risk has been observed in bipolar and depression cohorts. Crump, Sundquist, Winkleby, and Sundquist (2013) examined a cohort of persons with bipolar disorder treated in inpatient and outpatient settings and reported SMRs for unnatural causes by suicide of 12.0 and 17.0. Zivin et al. (2015) examined a cohort of depressed veterans who received inpatient and outpatient services and reported a hazard ratio for suicide of 2.1.

Other researchers have reported greater mortality risk due to natural causes of deaths among population groups with mental illness. In a U.S. population-based cohort, Lin, Liang, Li, and Lu (2018) examined death certificates for schizophrenia and reported that the overall top causes of deaths were from heart disease and cancer. Tanskanen, Tiihonen, and Taipale (2018) replicated the findings of Lin et al. (2018) in an inpatient schizophrenia cohort and reported an increase in SMR for cardiovascular disease from 2.1 to 2.6. The SMR also increased for cancer from 1.5 to 1.9 (Tanskanen, Tiihonen, &

Taipale, 2018). Almeida et al. (2014) reported higher proportion of deaths due to cardiovascular disease and cancer in schizophrenia (52%), depression (54%), and bipolar (59%) cohorts of older men.

In the U.S. PMHS, contrasting reports of the leading causes of death among persons with mental illness have also been observed. Miller et al. (2006), Piatt et al. (2010), and Sherman et al. (2013) reported greater mortality risk due to unnatural causes of death such as suicide and accidents while Daumit et al. (2010) and Colton and Manderscheid (2006) reported higher mortality risk due to natural causes of deaths such as cardiovascular disease and cancer. The shortage in specificity and incongruencies on findings pose challenges in assigning priorities for action at the PMHS under study. It is then critical to understand the leading causes of death in population groups with mental illness served in the PMHS to target efforts driven at improving health outcomes.

Therefore, the main purpose of this study was to examine the relationship between mental illness and the risk for all- and specific-cause of deaths that occurred in a PMHS between 2010 and 2014. The comparison was made between individuals served in a PMHS and individuals in the general population. The specific objectives of the study were to: compare the proportional mortality for the leading causes of death; estimate the difference in excess mortality (*SMR*) by cause of death between study group; assess the excess mortality (*SMR*) by demographic characteristics for persons served in the PMHS; estimate the difference in years of potential life lost (*YPLL*) by cause of death among the study group and, to estimate the adjusted mortality risk (*OR*) by cause of death. I hypothesized that there was a statistically significant difference in the mortality risk for

all- and specific-cause of death for individuals with mental illness served in a PMHS than for individuals in the general population.

Significance

Findings from this research may provide specificity about the leading causes of death experienced by individuals served in the PMHS under study. This information may help in prioritizing efforts for the implementation of evidence-based preventive practices.

Relevant Scholarship

Current knowledge about the causes of deaths among individuals with mental illness is conflicting, presenting challenges for action. New knowledge to be gained relates to the estimation of the likelihood of mortality by cause of death when controlling for demographic characteristics.

Research Questions and Design

1. What is proportional mortality for leading causes of death by study group (individuals served in a PMHS versus general population)?

2. What are differences in terms of SMR between individuals served in a PMHS and individuals in the general population according to specific causes of deaths?

3. What are differences in terms of SMR for individuals served in a PMHS according to cause of death and demographic characteristics?

4. What are differences in terms of YPLL between individuals served in a PMHS and individuals in the general population according to specific causes of deaths?

5. What is the adjusted mortality risk odds ratio for individuals served in a PMHS according to cause of death compared to individuals in the general population?

The study was quantitative and involved an analysis of retrospective data for a cohort of individuals who died between January 1, 2010, and December 31, 2014.

Methods

Target Population

The proposed study included all persons who received mental health services from a PMHS between January 1, 2010, and December 31, 2014 which were matched with death records. The PMHS executive team coordinates community-based and inpatient mental health treatment services and serves mainly African-American individuals. The comparison group was composed of all decedents from the general population that were not served in the PMHS.

Sample and Power

The study sample included all adults 18 years and older who received mental health services from a PMHS and died between January 1, 2010, and December 31, 2014. The sample also included all decedents 18 years and older in the general population not served in the PMHS under study.

To investigate the difference in SMR by cause of death, chi-square was used to determine the expected death counts. For a medium effect size of 0.3, an alpha error of 0.05, and a power of 0.95, a total of 145 cases were needed. To investigate the difference in YPLL by cause of death, a *t*-test was used. For a medium effect size of 0.50, an alpha error of 0.05, and a power of 0.95, 176 cases were needed. To estimate the mortality risk, logistic regression was used. For a two-tailed test with an alpha error of 0.05, 238 cases were needed for each test.

Procedure

Death data from DOH were linked with data for all decedents that received mental health services from the PMHS under study between January 1, 2010, and December 31, 2014, to determine dead cases. Decedents 18 years and older that were matched with mental health service data were included in the PMHS served group. Unmatched decedents were part of the general population group. Decedents younger than 18 years were excluded from the study.

Variables and Sources of Data

Dependent variable. The dependent variable was the risk for mortality by cause of death. The causes of death were categorized in natural and unnatural causes of deaths following the CDC guidelines for tabulating mortality statistics (US Department of Health and Human Services [DHHS], 2009). A natural cause of death refers to a death that occurs as a result of the natural aging process or a disease (DHHS, 2009). An unnatural cause of death results from an external cause such as intentional injury (assault/homicide or suicide) or unintentional injury (accidents) (DHHS, 2009). Accidents include transport accidents (e.g., motor vehicles), and non-transport accidents (e.g., drowning, exposure to smoke due to fire, poisoning, drug overdose). Table 6 shows the top 10 causes of death included for analysis. The SMR represents excess mortality as measured by the ratio of the observed and expected number of deaths. The YPLL represents the surplus in the year lost. Gender- and age-specific life expectancies were collected from life tables and were used to subtract the age at death for each individual and obtained YPLL (Arias, 2014; Arias, 2015; Arias, Heron, & Xu, 2016; Arias et al.,

2017; Arias et al., 2018).

Table 6

Top 10 Causes of Death Included for Analysis

Cause of death	ICD-10 Code
Natural causes	
Cardiovascular disease (CVD)	I00-I99
Cancer	C00-C97, D00-D48
Respiratory disease	J09-J18,N J20-J22, J30-J39,N J40-J47, J60-J98,NJ019, J029, J039-J040, J051, J069, U04
Infections	A00, A01-09, A16-A44, A46, A48-A49, A50-84, A85.0-A85.2, A85.8, A86, B04-B09, B15-B99
Diabetes mellitus	E10-E14
Alzheimer disease	G30
All other diseases	D65-E07, E15-E34, E65-F99, G04-G12, G14, G23-G25, G31-H93, K00-K22, K29-K31, K50-K66, K71-K72, K75-K76, K83-M99, N13.0-N15.0, N15.8-N15.9, N20-N23, N28-N39, N41-N64, N80-N98
Unnatural causes	
Accidents (including transport, non-transport, and other accidents)	V01-V99, W00-W99, X00-X59, Y10-Y35, Y85, Y86, Y87.2, Y89, Y89.9
Assault (homicide)	U01-U03, X85-X99, Y01-Y09, Y87.1
Suicide	U03, X60-X84, Y87.0

Independent variables. Demographic characteristics (age at death, gender, and race) and socio-economic factors (educational level and marital status) were retrieved

from death certificates. The type of service, last service date, and Medicaid status were collected from the PMHS service data system. The last service date and death date were used to compute time to death after the last service date. For the bivariate correlation, the independent variables were study group (individuals served by the PMHS, general population), gender, and race.

Design and Analysis

The design of the study was quantitative and involved a retrospective secondary analysis of cohort data. Descriptive analysis included frequency statistics for decedents served in the PMHS under study and decedents in the general population, and for the proportional mortality for the top causes of death. Inferential analyses included chi-square, *t*-test, and binary logistic regression. Chi-square was used to determine the expected number of deaths for the SMR calculations. The SMRs for each cause of death were obtained from contingency tables and 95% confidence intervals were computed by exponentiating the natural log of the risk ratio. The difference in mortality risk was computed by subtracting the SMR of the exposed or served in the PMHS from the SMR of the not exposed or people in the general population. The YPLL for each cause of death indicates the average number of years a person (gender- and age-specific) would have lived had she/he has not died prematurely due to the stated cause of death. A *t*-test was used to examine the difference in average YPLL between study groups. Because the population served in the PMHS under study had different age and gender distributions compared to the general population, age, and gender adjustment were performed before the computation of YPLL. The direct standardization procedure recommended by the

CDC was used and a weight was computed (Curtin & Klein, 1995). The formula for the computation of the weight was $W = P_{GP}/P_{PMHS\ served,}$ where W was the final analysis weight for each PMHS case by age and gender; P_{GP} was the proportion of the general population for each age and gender; $P_{PMHS\ served}$ was the proportion of the total PMHS population served for each age and gender. If the PMHS under study served higher proportion of persons in a specific age group than the proportion of persons in the same age group in the general population, then a weight less than 1 was applied. If vice versa, a weight higher than 1 was applied.

Binary logistic regression was performed for each cause of death to determine the adjusted mortality risk of individuals served in the PMHS under study in relation to individuals in the general population not served in the PMHS. Analyses were performed on SPSS version 26 and the significance level was set at $p < .05$, two-tailed. When the confidence intervals excluded 1.0, the standardized mortality ratio was considered statistically significant.

Results

Execution

The data set provided by the PMHS under study contained most of the information requested and needed to perform all proposed analyses. However, only between-group comparisons were possible as the information about the psychiatric diagnosis needed to classify decedents as SMI versus no SMI was not provided. Therefore, within-group comparisons were not conducted. Employment status was dropped from analysis as 75% of the data were missing.

Descriptive analysis. In the 5-year period from 2010-2014, 1,234 deaths occurred from individuals that were served in the PMHS under study. Deaths in the PMHS represented 5% the total deaths that occurred in the overall general population. Table 7 presents the demographic characteristics of the study sample. The majority of deaths were from females (75%), persons who were Black (77%), who had completed high school or higher education (72%) and were not married (74%). Persons served in the PMHS under study on average died at 54.5 years and lost on average 23 years due to early mortality.

Figure 4 presents the proportional mortality (PM) for the top 10 causes of deaths by study group (PM_{PMHS} versus PM_{GP}). Individuals in the study died mainly of cardiovascular disease (CVD) (35%), cancer (24%,), other diseases (11%), respiratory disease (6%), and infections (5%). PM_{PMHS} were greater than PM_{GP} for accidents, infections, assaults, and suicide.

Table 8 presents the difference in excess mortality between a cohort of individuals served in the PMHS under study and the individuals in the general population. People served in the PMHS under study experienced excess mortality for the unnatural causes of death estimated at SMR = 2.73 (95% *CI*, 2.36-3.90) compared with their counterparts in the general population. The SMR among persons served in the PMHS under study was even higher for accidents at SMR = 2.97 (*95% CI*, 2.44-4.56) and a slightly lower for assaults at SMR = 2.32 (*95% CI*, 1.49-4.21) and suicide at SMR = 2.30 (*95% CI*, 1.14-5.36). Except for infections, all other deaths due to natural causes were more prevalent in the general population group. Figures 5 - 7 present SMRs for people served in the PMHS

under study by gender, race, and age group. Males experienced excess mortality for all unnatural causes of deaths compared to females, and decedents who were White experienced excess mortality for accidents than decedents who were Black, but these differences were not statistically significant ($p>.05$). Although decedents whom were White experienced excess mortality due to respiratory disease and decedents who were Black experienced more deaths due to infections and assault than expected, these differences were not statistically significant ($p>.05$). Decedents served in the PMHS under study who were 18 - 24 years old excessively died of unnatural causes of deaths. Decedents 25 - 44 years old experienced excess mortality due to assault and suicide.

Table 7

Characteristics of Decedents Between 2010 and 2014

	All decedents *N*=22,668 (%)	Decedents served by PMHS *n*=1,234 (%)	Decedents in the general population *n*=21,434 (%)	*p* value
Gender				
Male	5,694 (25)	683 (55)	5,011 (23)	
Female	16,971 (75)	551 (45)	16,420 (77)	.000
Missing	3 (0)	0 (0)	3 (0)	
Race				
Whites	4,721 (21)	117 (9)	4,604 (21)	
Blacks	17,428 (77)	1,090 (88)	16,338 (76)	.000
Other races/ Unknown	519 (2)	27 (3)	492 (3)	
Age Groups				
18-24 years	297 (1)	40 (3)	257 (1)	
25-44 years	1,340 (6)	162 (13)	1,178 (6)	.000
45-64 years	6,167 (27)	801 (65)	5,366 (25)	
≥65 years	14,864 (66)	231 (19)	14,633 (68)	
Education				
<high school	5,491 (24)	308 (25)	5,183 (24)	
≥high school	16,327 (72)	827 (67)	15,550 (73)	.116
Missing	850 (4)	99 (8)	751 (3)	
Marital Status				
Married	5,314 (23)	160 (13)	5,154 (24)	
Not married	16,752 (74)	997 (81)	15,755 (74)	.000
Missing	602 (3)	77 (6)	525 (2)	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	
Age at death	71.1 (17.4)	54.5 (12.9)	72.1 (17.1)	.000
YPLL	16.8 (12.4)	23.0 (11.4)	16.2 (12.2)	.000

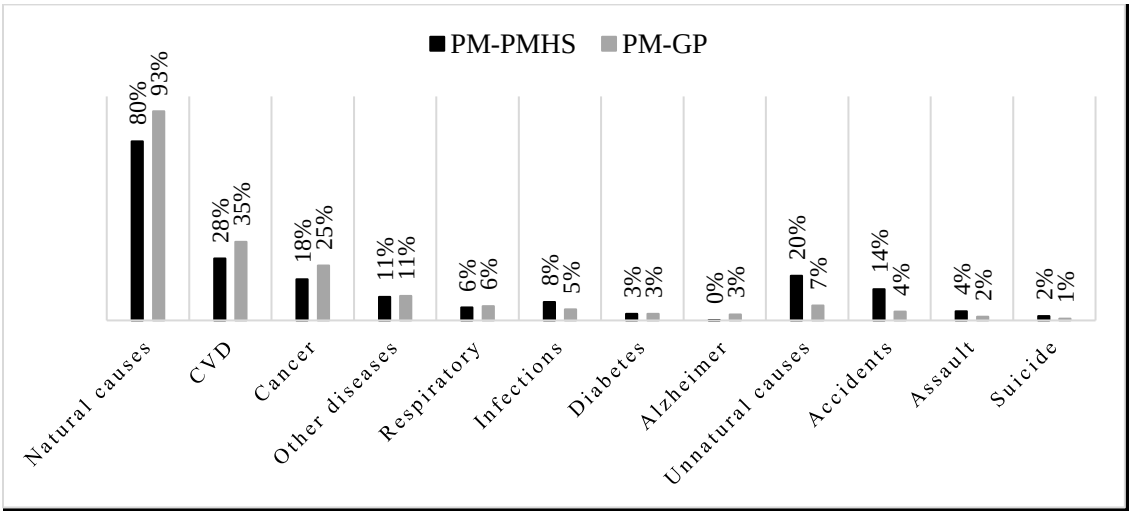

Figure 5. Premature mortality (PM) for the leading causes of death by study group.

Table 8

Difference in SMRs by Study Group According to Cause of Death

	Decedents served by PMHS *n*=1,234	Decedents in the general population *n*=21,434	PMHS-GP SMR diff
	SMR (95% *CI)*	*SMR* (95% *CI)*	
All causes	0.99 (0.91-1.01)	1.00 (0.97-1.03)	-0.01
Natural causes	0.84 (0.77-0.92)	1.01 (0.98-1.04)	-0.17
CVD	0.79 (0.68-0.91)	1.01 (0.97-1.06)	-0.22
Cancer	0.76 (0.63-0.89)	1.01 (0.96-1.07)	-0.25
Respiratory	0.91 (0.65-1.26)	1.01 (0.90-1.11)	-0.10
Infections	1.62 (1.21-2.32)	0.97 (0.85-1.09)	0.65
Diabetes	1.00 (0.62-1.61)	1.00 (0.85-1.16)	0.00
Alzheimer	0.03 (0.00-0.22)	1.06 (0.89-1.24)	-1.03
Other diseases	0.96 (0.75-1.23)	1.00 (0.92-1.09)	-0.04
Unnatural causes	2.73 (2.36-3.90)	0.91 (0.81-1.01)	1.76
Accidents	2.97 (2.44-4.56)	0.89 (0.78-1.00)	2.08
Assault	2.32 (1.49-4.21)	0.92 (0.76-1.13)	1.40
Suicide	2.30 (1.14-5.36)	0.93 (0.69-1.24)	1.55

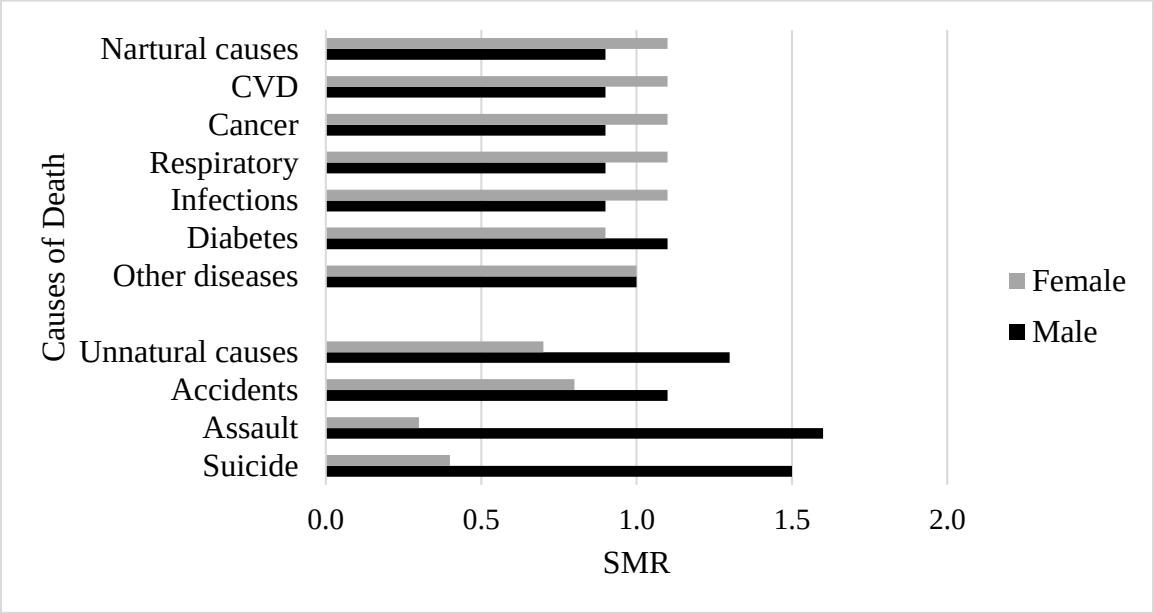

Figure 6. SMR for decedents served in the PMHS by gender.

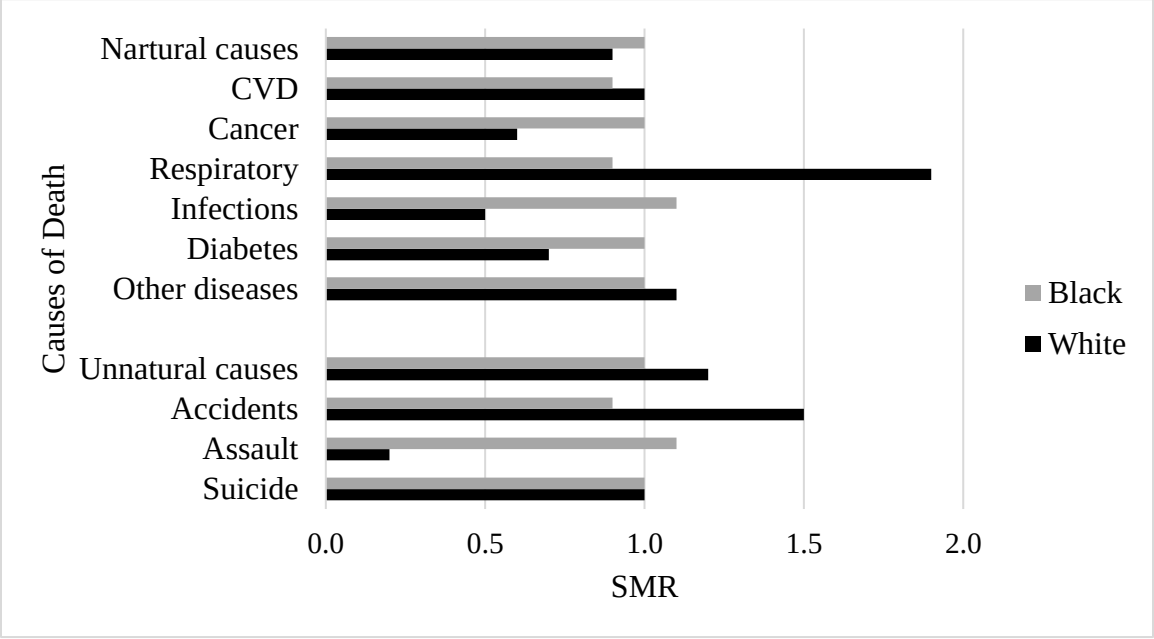

Figure 7. SMR for decedents served in the PMHS by race.

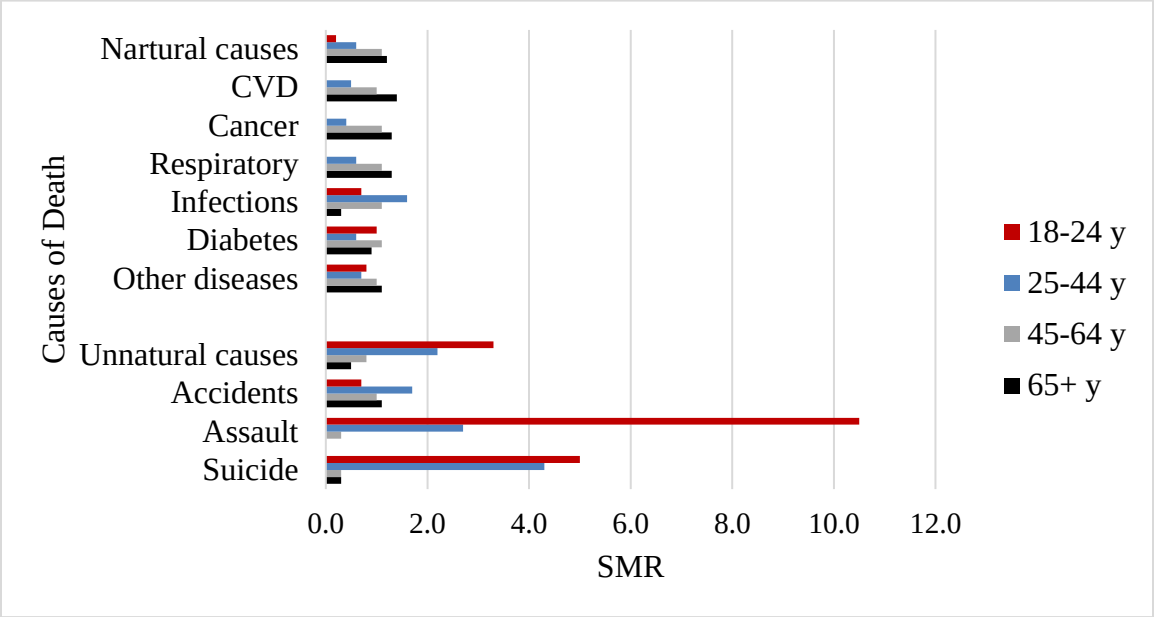

Figure 8. SMR for decedents served in the PMHS by age group.

Inferential analysis. The relationship between mental illness and causes of death was examined by testing differences in YPLLs and by estimating ORs by cause of death among the study groups. Table 9 presents the difference in YPLL between study groups. Decedents served in the PMHS under study prematurely lost 7.3 more years for all causes of death compared to individuals in the general population. Individuals served in the PMHS under study lost the greatest number of years due to natural causes of deaths such as nearly eight years for other diseases and seven years for respiratory and Alzheimer's diseases. In terms of unnatural causes of death, the greatest loss experienced by individuals served in the PMHS under study was due to suicide estimated at seven more years than a person in the general population would have lost.

ORs were calculated to evaluate the significant differences in the mortality risk for each cause of death by study group adjusting for decedents' gender and race. Figure 9

shows that the odds of mortality due to unnatural causes for persons served in the PMHS under study was almost three times greater than for persons in the general population. It was estimated at two times greater risk for accidents and almost 2.5 times greater risk for suicide. The OR for assault was not significant. Although respiratory and other diseases appear to have greater mortality risk, the difference was not significant therefore, no mortality risk was associated with the natural causes of death.

Table 9

Difference in YPLL by Study Group by Cause of Death

	Decedents served by PMHS *n*=1,234	Decedents in the general population *n*=21,434	PMHS-GP YPLL diff	*p* value
All causes	23.3	16.0	7.3	.000
Natural causes	21.2	14.7	6.5	.000
CVD	20.3	13.6	6.7	.000
Cancer	20.8	16.8	4.0	.000
Respiratory	19.8	12.6	7.2	.000
Infections	28.3	21.9	6.4	.000
Diabetes	21.6	15.7	5.9	.000
Alzheimer	13.1	6.1	7.0	.000
Other diseases	21.5	13.7	7.8	.000
Unnatural causes	34.1	32.5	1.6	.142
Accidents	29.0	25.7	3.3	.007
Assault	47.9	47.9	0.0	.993
Suicide	42.2	35.2	7.0	.029

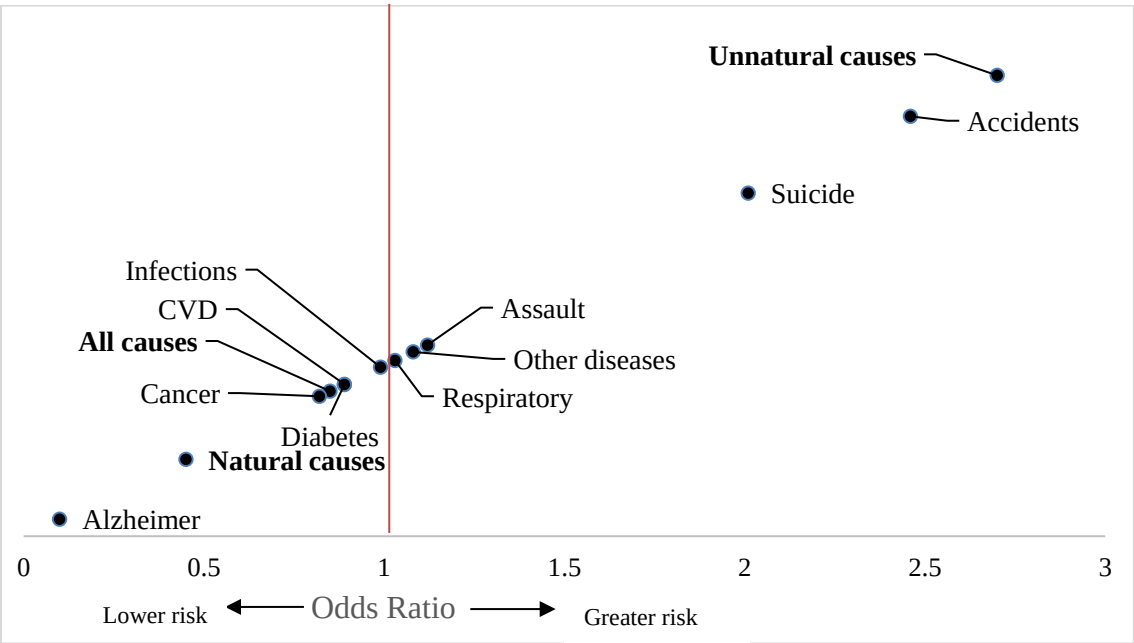

Figure 9. Adjusted mortality risk for people served in the PMHS compared with people in the general population.

Discussion

Interpretation

The main purpose of this study was to assess the relationship between mental illness and the risk for all- and specific-cause of death. The study sample was mainly composed of people who were Black receiving services in a PMHS for which the proportional mortality exceeded that of the general population mostly for unnatural causes of deaths. This initial assessment was the basis to assume that the mental illness of persons served in the PMHS under study could have been related to an increased mortality risk in causes of death.

SMRs showed that individuals served in the PMHS under study experienced almost three times greater excess mortality due to unnatural causes of death (*SMR* = 2.73

overall, *SMR* = 2.97 for accidents, *SMR* = 2.32 for assaults, and *SMR* = 2.48 for suicide). However, confidence intervals of SMRs for suicide and assault were wider confirming a lower count of deaths due to assault or suicide affecting the power of the findings. Findings align with Miller et al. (2006) that reported elevated SMRs for decedents served in the Ohio PMHS of 3.8 for accidents, 1.7 for assault, and 12.6 for suicide. In the PMHS under study there were differences for decedents who were 18-44 years old in the mortality due to unnatural causes of death (*SMR* = 2.53, *95% CI* 1.71-3.73). This outcome aligns with reports from Charrel et al. (2015) who reported a SMR = 3.89 for unnatural causes of death for people 18 - 34 years with all types of mental illness receiving services in a public psychiatric hospital. In the current study, SMRs for people who were aged between 18 and 44 years were greater for assault (*SMR* = 5.71, *95% CI* 2.41-13.57) and suicide (*SMR* = 4.50, *95% CI* 1.38-14.69), however, only 16% of all deaths were attributed to this group.

Decedents served in the PMHS under study experienced premature mortality in all-natural causes of death fluctuating from 13 to 28 years. Significant YPLL differences were observed for deaths due to accidents (29 years) or suicide (42 years) accounting for YPLL that were higher than the YPLL for any natural causes of death. However, only 23 deaths were attributed to suicide. While decedents served in the PMHS under study did not experience excess mortality in all-natural causes of deaths except for infections as measured by the SMR, they died younger accounting for greater YPLL share. There was also a significant relationship between individuals served in the PMHS under study and the OR due to unnatural causes of death. Individuals served in the PMHS experienced at

least two-fold OR due to unnatural causes of death, particularly accidents and suicide. Findings of the relationship between mental illness and mortality due to unnatural causes of death is largely in accordance with findings from Chesney et al. (2014), Crump et al. (2013), Heiberg et al. (2018), Hallgren et al. (2019), Ko et al. (2018), Melle et al. (2017), and Zivin et al. (2015).

The mortality due to unnatural causes of deaths was significantly related to mental illness. The SMR for accidents for the PMHS under study (2.97) was lower than the SMR reported by Miller et al. (2006) in a similar setting (3.8). The YPLL for accidents for the PMHS under study was higher (29 years) than the YPLL reported by Piatt et al. (2010) in a similar setting (26.5 years). The ORs provided supplementary information to help understand the relationship between mental illness and causes of death by examining the effect of mental illness on decedents for which the specific cause of death was present, compared with decedents for which the cause of death was absent, and make predictions of the mortality outcome.

Limitations

Some limitations warrant consideration when interpreting and applying the findings of this study. First, data from mainly Black decedents served in a PMHS may restrict generalizations to other mental health systems serving different racial populations. However, this population group has been understudied, therefore, understanding the mortality risk due to specific causes of deaths merited immediate attention. Second, because the sample under study was mainly composed of individuals who were severely sick, they were already at greater mortality risk. Even more, the

analysis by severe mental illness was not possible thus limiting the specificity of the findings. Third, in this study, matched death data from death certificates and mental health service data from the PMHS were analyzed. The matching procedure was under the control of the PMHS staff, therefore possible errors are unknown. However, the PMHS staff were trained on the matching procedure and on the manual and visual inspection of false non-matches, false matches, and duplicates. Finally, the population served in the PMHS under study by cause of death was not provided, therefore, the expected deaths for the PMHS needed for the calculation of the SMRs were computed using chi-square rather than applying a standard reference population. This could have under- or over-estimated the observed SMRs. However, chi-square is based on observed relative frequencies and it is assumed that these frequencies are representative of the overall population.

Implications

Although unnatural causes of death accounted for 20% of all deaths experienced by people served in the PMHS under study, they were attributed to greater mortality risk. Deaths due to accidents pose an important public health challenge. Of all deaths due to accidents among individuals with mental illness served in the PMHS, 56% were due to drug overdose which may be preventable and may well respond to effective low-cost interventions. Interventions may have the potential of averting unwanted deaths, decreasing the mortality frequency, and preventing excess mortality, premature death, and mortality risk. Staff from the PMHS under study may want to identify interventions and adapt them in the PMHS under study.

Individuals served in the PMHS under study experienced excess mortality (*SMR*) due to accidents, suicide, and assault. Individuals also experience premature mortality (*YPLL*) due to natural causes of deaths, accidents, and suicide. The increased OR was due to accidents and suicide. Three approaches (*SMR, YPLL*, and *OR*) to measure the relationship between mental illness and the causes of death converge in the unnatural causes of deaths, particularly accidents and suicide. However, deaths due to suicide represented a small number making it unfeasible to reach definite conclusions. Therefore, priority could be given to deaths due to accidents. Finally, for all causes of death, decedents served in the PMHS under study significantly lost 7.3 (p = .000) more years than decedents in the general population. Mortality indicators provide evidence of the adverse impact mental illness could have over the mortality risk experienced by individuals with mental illness, mainly due to unnatural causes of death.

Recommendations

With the undesirable outcome of the relationship between mental illness and early mortality, it is important to further explore the mortality risk by specific mental disorders. This exploration could uncover what cause of death prevails by a specific psychiatric disorder.

Conclusion

Individuals served in the PMHS may be at greater mortality risk due to unnatural causes of death compared to individuals in the general population. Efforts may be focused on preventing accidents among this population group to avert deaths due to drug overdose.

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Examining the Mortality Risk of a Population with Mental Illness

Manuscript 3

Glorimar Ortiz

Outlet for Manuscript

The target journal for this manuscript will be *Epidemiology and Psychiatric Sciences*. The journal's URL is located at: https://www.cambridge.org/core/journals/epidemiology-and-psychiatric-sciences/information/converting-to-open-access-in-january-2020. The journal's formatting expectations include original articles should contain no more than 4,000 words (excluding abstract, references, tables/figures, which should be uploaded in a separate file). The abstract should be structured using the subheadings Aims, Methods, Results, Conclusion, and should not exceed 400 words. The article should contain no more than a combined total of six tables and/or figures. Authors must also select four key words to be included. The first page must contain: title and short title for running head (not more than 60 characters); author's name (only the initial of the author's fist name/s should be given, followed by the surname/s); department in which the work was done; and word count of text excluding abstract, tables/figures, and reference list. All papers must be written in English and should include at the end of the text (before the References section), the Required Statements (Acknowledgements, Financial Support, Conflict of Interest, and Ethical Standard). Also, S.I. units should be used throughout the text, tables and figures; all abbreviations should be spelled out; and foreign quotations and phrases should be followed by a translation. Other formatting instructions include: divide the manuscript into headings: Introduction, Methods, Results, Discussion; underline words and phrases in the text that should be printed in italics; use a dot before a decimal rather than a comma; cite in the text only the references that are included in the references list. The

Harvard system should be used in the text and a complete list of references cited given at the end of the article. The References section should be in alphabetical order.

The journal aligns with the content in the manuscript because its focus is to publish research with updated data and scientific information to a wide variety of audiences that include epidemiologist, psychiatrist, psychologists, statistician and other research and mental health workers. These audiences are the ones that are in continuous contact with the population group under study. Understanding who is at risk of premature mortality will be of great interest to these audiences and could help in promoting health care changes for the population group they serve.

Title Page

Predictors of Premature Mortality Among Individuals with Mental Illness Served in the Public Mental Health System

Glorimar Ortiz, M.S.

Walden University

glorimar.ortiz@waldenu.edu

Abstract

Background: Premature mortality among people with mental illness is prevalent. Applying a multi-level ecoepidemiologic framework of health, disease, and mortality may provide insights into the prevention of premature mortality among individuals with mental illness served in a public mental health system (PMHS).

Purpose: The aim of this study was to determine the predictors of premature mortality among a primarily Black sample who was served in a PMHS.

Methods: Death data from 2010-2014 from a cohort of 1,234 decedents served in a PMHS were retrospectively abstracted and matched with death records. Multiple linear regression was used to determine the predictive risk factors associated with high scores in YPLL.

Results: Marital status, tobacco use, being Black or female undesirably influenced the scores on YPLL accounting for 15% of the variance in YPLL. Never being married accounted for the highest number of years lost (at least 6.78 years).

Conclusion: It was found that higher scores on the YPLL were significantly related to a person served in a PMHS who was a female, or Black, or never married, or tobacco user. An individual with these characteristics may expect to lose nearly 18 years due to premature mortality. Never married was the strongest predictor. Racial differences in the YPLL scores may be addressed during active treatment provided in the PMHS and after discharge from the system in coordination with the next level of care provider.

Key words: *mental illness, public mental health system, YPLL, risk factors*

Introduction

Mental illness is common in the U.S. accounting for 20% of the population aged 18 years and older representing 48 million people (National Alliance on Mental Illness [NAMI], 2019). Usually, state and local governments have the primary responsibility of providing mental health care and coordinating treatment through PHMSs (Sundararaman, 2009). Depending on the individual's mental health needs, treatment may occur in inpatient or community-based settings that include outpatient and residential treatment programs or a combination. PMHSs accommodate mental health reforms that drive the care for persons with mental illness. The current mental health policy agenda promotes a community-based, person-centered, and recovery-oriented mental health care model (Fisher et al., 2009). PMHSs serve population groups that are considered high-risk groups as they typically are heavy smokers and drinkers (Toftdahl et al., 2016), have poor diets (Dipasquale et al., 2013) and poor physical health (Vancampfort et al., 2015). Persons with mental illness served in PMHS are also sicker than people in the general population (Druss et al., 2011), and a higher proportion could also meet criteria for disability (Daumit et al., 2010; Papas et el., 2015). The average educational level for persons served in PMHSs is below high school (Burgess, Curtis-Downes, & Gibson, 2013), served individuals have low incomes (Daumit et al., 2010; Papas et al., 2015), are unemployed (Miller et al., 2006), lack stable housing (Shan & Sandler, 2016), and are unmarried (Piatt et al., 2010). Premature and excess mortality are threats among the population group served by PMHSs. Colton and Manderscheid (2006) and Piatt et al. (2010) observed a disparity in the average of years loss of 10 to 25 years for individuals with mental illness

served in PMHSs compared with individuals not served in the systems. Colton & Manderscheid (2006), Daumit et al. (2010), Sherman et al. (2013), and Papas et al. (2015) reported more than two times excess mortality among individuals served in PMHSs compared to individuals in the general population not served in PHMSs. Thus, individuals that are treated for mental illness may present care and treatment challenges for PMHSs. Understanding the predictors that account for early mortality may contribute to the promotion of care changes and subsequent mortality risk reduction.

Papas et al. (2015) examined the predictors of premature mortality among individuals who received Medicaid services in Delaware and reported that decedents who were male, White, and receiving disability compensation were at higher risk of premature mortality. Factors associated with the system of care itself were associated with premature mortality. While Papas et al. (2015) analyzed data from a publicly funded population group they focused on factors related to the Medicaid system which is important but primarily targets distal factors associated with the likelihood of premature mortality. Dickerson et al. (2016) and Dickerson et al. (2018) revealed that tobacco use was the strongest predictor of premature mortality among individuals with schizophrenia and bipolar disorders who received mental health services in inpatient and outpatient programs. Other predictors included being divorced or widowed and experiencing physical comorbidities. Both Dickerson et al. (2016) and Dickerson et al. (2018) focused on decedents with severe mental illness that were not treated in PMHSs, died of natural causes, and excess mortality was ascertained as the time to death from beginning of service until death or the end of the study. The main strength of the current study,

different from Dickerson et al. (2016) and Dickerson et al. (2018), is that the actual age at death for each decedent was used to calculate age- and gender-adjusted years of YPLL and included all individuals without distinction on the cause of death.

The current study first examined the mortality risk of individuals served in a PMHS as determined by the YPLL and longitudinally compared the outcome by gender and race. Predictors of premature mortality were identified from a matched database of death records and services data provided by the PMHS under study. Deaths occurred between January 1, 2010, and December 31, 2014. Predictors were framed under a modified multi-level ecoepidemiological life course framework for health, illness, and mortality cross-continuum. Embedded within the cross-continuum is the potential to understand how people with mental illness stay healthy with their chronic mental condition as well as how long these people live over time and space as the population ages (Defo, 2014). Characteristics at the micro-level (proximal factors), meso-level (intermediate factors), and macro-level (distal factors) could create interconnected links and may influence the population's health. I intended to enhance the current knowledge about predictors of premature mortality among people with mental illness by including risk factors at all levels of causation. While Papas et al. (2015) focused on distal and proximal factors, Dickerson et al. (2018) and Dickerson et al. (2016) focused on intermediate and proximal factors. Using linkages from death and services data, the main goal of the current study was to identify the predictors of premature mortality among decedents served in a PMHS at proximal, intermediate, and distal levels of causation. I hypothesized that there was a statistically significant predictive relationship between

distal (time to death after last service), intermediate (tobacco use), and proximal (gender, race, educational level, marital status, and Medicaid) factors and premature mortality as measured by the YPLL.

Significance

Findings from this study may elucidate specificity about predictors and premature mortality for individuals receiving mental health services in the PMHS. Unique to the current study is that it was framed under an ecoepidemiological model of health, disease, and mortality. Findings from the framework may prompt the implementation of evidence-based practices already in place in other healthcare settings. It may also provide information for better allocation of resources.

Relevant Scholarship

Current knowledge indicates that demographic and behavioral factors among people with mental illness contribute to premature mortality. Knowledge to be gained includes an understanding of predictors of premature mortality that are framed under an ecoepidemiological framework of health, disease, and mortality and that considers all levels of causation within the framework. The findings may suggest initiatives that may prevent premature mortality among individuals served in the PMHS.

Research Questions and Design

1. What is the average YPLL trend for decedents served in the PMHS between 2010 and 2014 by gender?

2. What is the average YPLL trend for decedents served in the PMHS between 2010 and 2014 by race?

3. What is the predictive relationship between gender, race, educational level, Medicaid status, marital status, tobacco use, and time to death and premature mortality as measured by the YPLL among decedents served in a PMHS between 2010 and 2014?

The study was quantitative and involved an analysis of retrospective data for a cohort of individuals that died between 2010 and 2014.

Methods

Target Population

The proposed study included all persons who received mental health services from a PMHS between January 1, 2010, and December 31, 2014 and were matched with death records.

Sample and Power

The study sample included all decedents 18 years and older who received mental health services from a PMHS and died between January 1, 2010, and December 31, 2014. YPLL was regressed in a standard multiple regression model to identify predictors of premature mortality and its associated coefficients. Allowing a medium effect size of 0.15, an alpha error of 0.05, a power of 0.95, and seven predictors, the total sample needed was 184 cases.

Procedure

Data for this study came from a matched database of death data from DOH and mental health service data from a PMHS. The mental health data included abstracts of all decedents 18 years and older that received mental health services from the PMHS between January 1, 2010, and December 31, 2014. Death data included information for

all decedents in the general population and served in the PMHS. Decedents younger than 18 years were excluded from the study.

Variables and Sources of Data

Dependent variable. YPLL indicates the average number of years a person (gender- and age-specific) would have lived had she/he has not died prematurely. The YPLL represents the surplus in the years lost and tells the loss in life expectancy. The gender- and age-specific life expectancies were collected from life tables for each study year generated by the CDC and were used to subtract age at death for each individual and obtained the YPLL (Arias, 2014; Arias, 2015; Arias, Heron, & Xu, 2016; Arias et al., 2017; Arias et al., 2018).

Independent variables. Table 10 presents the independent variables included in the regression equation. Seven variables were grouped according to their level of causation, either distal, intermediate, or proximal in the ecoepidemiological framework for health, disease, and mortality. Information for independent variables was abstracted either from the death records (death date, tobacco use, gender, and race) or the PMHS service database (last service date, educational level, Medicaid status, and marital status). Time to death was calculated from death date and last service date. Because only the month and the year of the date of death were submitted, when calculating the time to death, it was assumed that individuals died on the first day of a given month.

Table 10

Operational Measures for Independent Variables

Variable	Detail	Data source	Status
Distal factors			
Time to death	Time to death after last service date	PMHS	Calculated from last service date and death date
Intermediate factors			
Tobacco use	Yes/No	Death records	Given
Proximal factors			
Gender	Male/Female	Death records	Given
Race	White/Black/Latino/Other	Death records	Given
Educational level	<high school/≥high school	PMH service database	Given
Medicaid status	Medicaid eligibility status	PMHS service database	Given
Marital status	Never married	PMHS service database	Given

Design and Analysis

The design of the study was quantitative and involved a retrospective secondary analysis of cohort data. Descriptive analysis included frequency statistics of the characteristics of the sample. Time to death was created from death date and date of last service. The inferential analysis included a *t*-test to explore the relationship between YPLL scores in each study cohort. T-test was also used to test differences in YPLL scores between gender and race. Standard multiple linear regression was used to determine the predictors of premature mortality as measured by the YPLL in a sample of decedents served in a PMHS. In a standard multiple regression, all predictors were

entered in one step. Zero-order, part, and partial correlations of each predictor with YPLL were requested to evaluate the effect sizes of individual predictor variables. Because the population served in the PMHS under study had different age and gender distributions compared to the general population, age, and gender adjustments were performed before the computation of YPLL. The direct standardization procedure recommended by the CDC was used and a weight was computed (Curtin & Klein, 1995). The formula for the computation of the weight was $W = P_{GP}/P_{PMHS\ served,}$ where W was the final analysis weight for each PMHS case by age and gender; P_{GP} was the proportion of the total population for each age and gender; $P_{PMHS\ served}$ was the proportion of the total PMHS served population for each age and gender. If the PMHS under study served a higher proportion of persons in a specific age group than the proportion of persons in the same age group in the general population, then a weight less than 1 was applied. If vice versa, a weight higher than 1 was applied. Pairwise was used to treat missing data, particularly for tobacco use. Statistical analyses were performed on SPSS version 26 and the significance level was set at $p < .05$, two-tailed.

Results

Execution

The data set provided by the PMHS contained most of the information requested. The information about psychiatric diagnosis needed to classify decedents as SMI versus no SMI was not provided. Therefore, that level of comparison was not possible. Employment status was dropped from analysis as 75% of the data were missing.

Descriptive analysis. Table 11 presents a description of the sample under study.

The majority of deaths were from males (55%), who were Black (88%), completed high school or higher education (67%), were never married (57%), and received Medicaid services (84%). Persons served in the PMHS under study on average died of 54.5 years and 78% lived less than a year after the last service date. Eighty percent died of natural causes.

Table 11

Characteristics of Decedents Served in the PMHS Between 2010 and 2014

Characteristic	N	%
Gender		
Males	683	55.3
Females	551	44.7
Race		
Black	1,090	88.3
White	117	9.5
Other races/Unknown	27	2.2
Education		
Less than high school completed	308	25.0
High school completed	592	48.0
Above high school completed	235	19.0
Missing educational level	99	8.0
Marital Status		
Never married	703	57.0
Divorced	213	17.3
Widowed	81	6.6
Married	160	13.0
Missing marital status	77	6.2
Age Groups		
18-24 years	40	3.2
25-44 years	162	13.1
45-64 years	801	65.0
≥65 years	231	18.7
Medicaid beneficiary	1,032	83.6
Time to death after last service		
Less than 1 year	959	77.7
1-2 years	218	17.7
3 or more years	57	4.6
Died of natural causes	988	80.1

Inferential analysis. The longitudinal exploration of the relationship between mental illness and YPLL showed that on average, individuals served in the PMHS under study lost 23 years per cohort year (see Table 12). The premature mortality remained constant during the 5-year period. Figures 10 and 11 display the relationship between mental illness and YPLL by demographic characteristics. Except for 2010 cohort, there were no statistically significant differences in YPLL between males and females. However, there were significant differences in YPLL among races for all study cohorts with Blacks consistently experiencing greater premature mortality than Whites. Table 13 provides the results of the standard multiple regression. The assumptions required for the multiple regression were met. The overall regression, that included seven predictors, was statistically significant ($F(7, 564)=15.04$, $p < .001$) (Table 13). Four predictors were significantly predictive of high YPLL scores including gender, $t(1,768)=-2.42$, $p=.016$; race, $t(1,723)=3.95$, $p <.001$; never married, $t(1,629)=7.21$, $p <.001$; and tobacco use, $t(638)=2.89$, p .004.

Table 12

YPLL Trend for Decedents Served in the PMHS

Cohorts	All clients		
	Deaths	YPLL	95% CI
2010	175	23.47	22.01-24.92
2011	214	22.78	21.46-24.09
2012	219	23.34	22.12-24.56
2013	283	23.28	22.17-24.39
2014	343	23.49	22.39-24.59
All cohorts	1,234	23.28	22.74-23.82

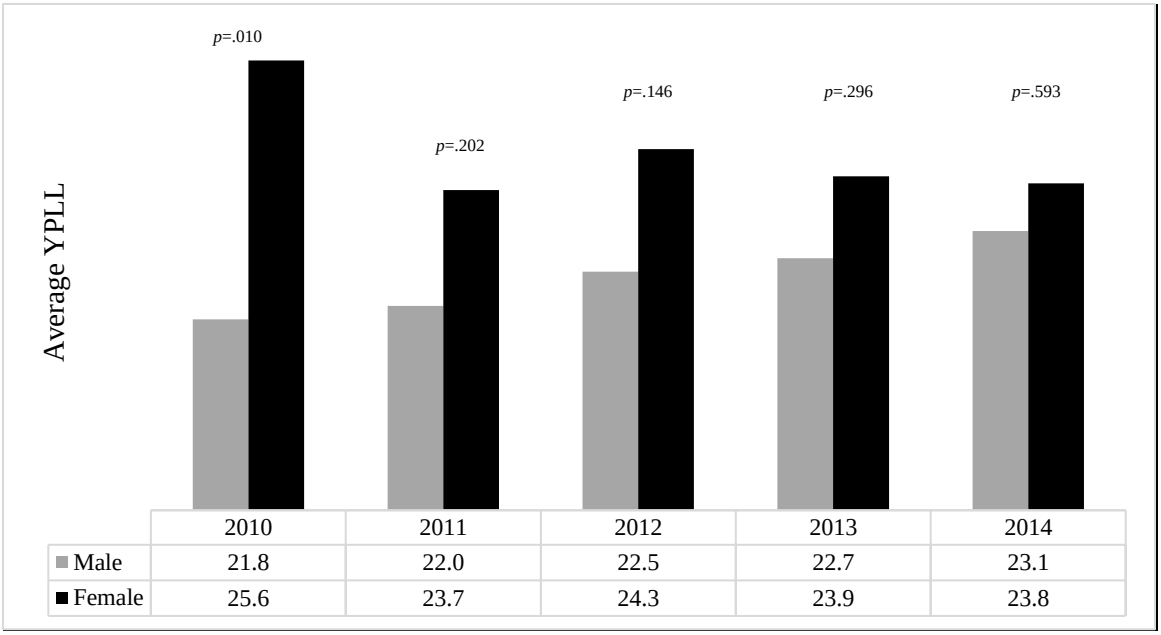
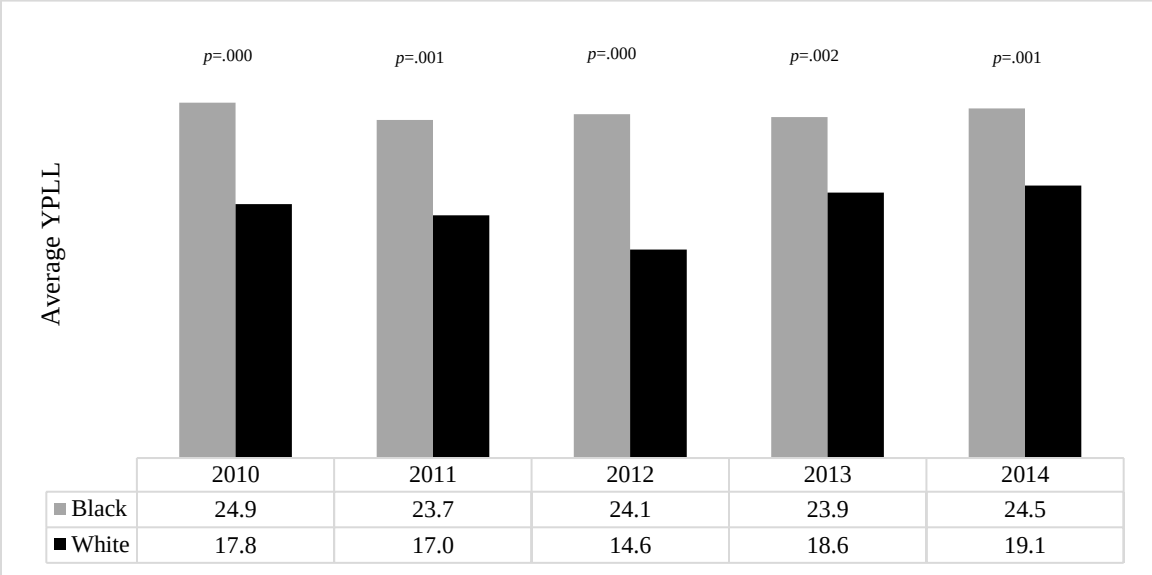


Figure 10. Average YPLL trend for decedents served in the PMHS between 2010 and 2014 by study year and gender.



	2010	2011	2012	2013	2014
Black	24.9	23.7	24.1	23.9	24.5
White	17.8	17.0	14.6	18.6	19.1

Figure 11. Average YPLL trend for decedents served in the PMHS between 2010 and 2014 by study year and race.

Table 13

Predictors of High YPLL Scores for Decedents Served in a PMHS Between 2010 and 2014

Factors	YPLL	1	2	3	4	5	6	ß	sr^2 unique	*p* value
Gender	-.07							2.25	.01	.016
Race	.18	-.07						5.44	.02	.000
Education	-.05	-.10	-.09					-.77	.00	.467
Never married	.31	.16	.06	-.02				6.78	.08	.000
Medicaid Status	.17	-.03	.12	-.07	.20			1.81	.00	.114
Tobacco	.15	-.04	-.06	-.04	.09	.15		3.85	.01	.004
Time to death	-.07	.03	.06	-.03	-.07	-.11	.02	1.32	.00	.212
Intercept=8.49										
R^2=.16										
R^2 adj=.15										
R=.40										

Note. Proximal factors: 1 = gender; 2 = race; 3 = education level; 4 = never married; 5 = Medicaid status. Intermediate factor: 6 = tobacco use. Distal factor: 7 = time to death.

Discussion

Interpretation

The main purpose of the study was to identify the significant predictors of high scores on YPLL. Decedents in the cohorts experienced an average YPLL of 23 years. This average is consistent with current YPLL estimates for individuals with mental illness. The YPLL trend remained constant at 23 years from 2010 to 2014, which may suggest that individuals in a specific age group experienced the largest mortality burden. However, the number of deaths persistently increased. Individuals served in the PMHS under study could expect to experience a loss in life expectancy of 9-25 years. This align with results from studies where the unadjusted YPLL, without controlling for multiple factors, was examined even with population groups demographically different than the group in the current study.

The adjustment for proximal, intermediate, and distal factors provides specificity into what factors are influencing the high scores on YPLL. The proximal and intermediate factors were positively related to early mortality but not the distal factor. While gender and race cannot be modified, the other two predictive factors can. The portion of variance uniquely explained by each predictor (sr^2_{unique}) showed that the strongest predictor was never married (sr^2_{unique} =8%). Dickerson et al. (2016) and Dickerson et al. (2018) also found a significant relationship between mental illness and marital status, particularly being divorced or widowed increased the risk of mortality by almost two-fold. In the current study, decedents that were never married died on average nearly seven years earlier. Marital status has been used as a proxy for social support,

therefore current findings and findings from Dickerson et al. (2016) and Dickerson et al. (2018) underscore the importance of strengthening the social support of individuals with mental illness.

Female and Black decedents could lose 2.25 and 5.44 years, respectively. Combined, females and Blacks could lose almost eight years (7.69). Decedents who were tobacco users at the time of death lost nearly four years due to premature mortality, which align with Dickerson et al. (2016) and Dickerson et al. (2018) who found that cigarette smoking presented an almost seven times higher risk for mortality among persons with schizophrenia or bipolar disorder. Overall, high YPLL scores were predictable from the set of predictors; the strongest unique predictive contribution was from never married with a smaller contribution from gender, race, and tobacco use. Targeting the predictive factors may decrease the risk in mortality among persons with mental illness served in PMHSs.

Limitations

The main limitation of the study relates to the external validity of the results. The data analyzed for the study came from a PMHS therefore, a generalization of the findings to other mental health systems may be limited. High YPLL score estimates may be associated with the level of severity of individuals in the sample. Employment status was dropped from analysis due to excessive missing data. How this factor could have affected the predictive formula is unknown. The analysis by severe mental illness was not possible thus limiting the specificity of the findings.

Implications

The individuals served in the PMHS under study experienced an upward mortality trend (in terms of the number of deaths) but a static average YPLL. With an average age at death of 54.5 years and an average YPLL of 23 ±12 years, this trend may suggest that persons between 43 and 67 may experience the largest mortality burden. This fact aligns with the 65% of decedents who died between 45 and 64 years old. This age group then becomes a high priority. The wide YPLL range estimate (9 - 25 years) may reflect the complexity of the population group served in the PMHS. Even a person with no mortality risk predictors may expect to lose almost nine years (intercept = 8.49 years) suggesting the pervasive adverse effect of mental illness. It was found that persons that were never married experienced a disparate higher YPLL which is conspicuous given the high rate of never married persons that are served in the PMHS.

Tobacco use negatively affected YPLL scores. Smoking continues to be the number one cause of preventable death in the U.S. (CDC, 2019b). Normally, individuals are smoke free when they receive mental health services in the PMHS. The time at discharge from the PMHS may represent an opportunity for smoking relapse, thus support for smoking cessation continuation is vital. Finally, clients who were females or Blacks were also at increased YPLL scores, suggesting the need for distinct solutions at the PMHS under study.

Recommendations

The staff at the PMHS under study may want to evaluate current approaches to mental health care that may need modification to address risk predictors of mortality.

Results from the multiple linear regression suggest the complexity of the problem that may need distinct and several approaches to improve YPLL scores among this population group. Predictors included in this study predicted 15% of the variance in the YPLL scores, underscoring that additional factors could improve current results. In the future, researches may investigate social support factors, behavioral factors such as the use of alcohol and other substances, and clinical factors such as the body mass index, medical comorbidities, and antipsychotic medication use. Researchers may also investigate the causes of death for individuals served in the PMHS particularly by demographic characteristics.

Conclusion

Higher scores on YPLL were significantly related to a person served in a PMHS who was a female, or Black, or never married, or tobacco user. An individual with these four characteristics may expect to lose nearly 18 years due to premature mortality. Never married was the strongest predictor. Racial differences in YPLL scores may be addressed during the active treatment provided by the PMHS staff and after discharge from the system in coordination with the next level of the care provider.

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Part 3: Summary

Introduction

The main purpose of three manuscripts was to explore the mortality of individuals with mental illness who were served in a PMHS and that died between January 1, 2010, and December 31, 2014. The mortality risk was examined by estimating SMR, YPLL, OR, and high-risk predictors of premature mortality. Excess, premature, and risks of dying were compared with the general population. Recent estimates are mainly from studies examining mortality among decedents served in developed countries with mental healthcare systems differently structured than the PMHS under study. Papas et al. (2015), Sherman et al. (2013), Piatt et al. (2010), and Miller et al. (2006) analyzed samples from PMHSs who were demographically different than the sample in the PMHS under study which may account for differences in the mortality risk.

Papas et al. (2015) investigated the predictors in a similar sample group but decedents were predominantly White. Papas et al. (2015) also focused mainly on the characteristics of the Medicaid system. Dickerson et al. (2016) and Dickerson et al. (2018) analyzed a demographically similar sample as greater proportion of decedents were Black but they were not served in a PMHS and the focus was on clinical and serological factors associated with infectious agents. While Papas et al. (2015), Dickerson et al. (2016), and Dickerson et al. (2018) added new perspectives to the early mortality among people with mental illness, it is still unknown how much of the variance in excess mortality is explained by the Medicaid system in Papas et al. (2015) or the clinical or the

serological factors Dickerson et al. (2016) and Dickerson et al. (2018). Therefore, decisions at the PMHS under study applying existing data were challenging.

Through analysis of data from an understudied sample, I estimated mortality risks of individuals with mental illness served in a PMHS. Through Manuscript 1, I found that individuals with mental illness served in the PMHS under study experienced excess (*SMR* = 1.78) and premature mortality (mean *YPLL*= 23 years), and increased mortality risk (*RR* = 30%). Compared to persons in the general population who were not served in the PMHS under study, a person with mental illness may expect to lose at least 18 years due to premature mortality.

Through Manuscript 2, I found that although the majority of decedents died mainly of natural causes of death, death patterns were very similar to the general population. Decedents who were served in the PMHS under study experienced almost a three-fold (*SMR* = 2.73) higher mortality risk due to unnatural causes of deaths including accidents (*SMR* = 2.97), assault (*SMR* = 2.32), and suicide (*SMR* = 2.30). Individuals served in the PMHS under study lost 7.3 more years due to all causes of deaths compared to individuals in the general population. The risk of dying was also significantly higher for accidents (*OR* = 2.46).

Through Manuscript 3, I found that four factors significantly impacted scores on YPLL and accounted for 15% of the variance in YPLL with never being married accounting for the highest number of years lost (6.78 years). Tobacco use, being Black, or female also influenced YPLL scores. The predictive model obtained from the regression provided an adjusted influence of risk factors on persons served in the PMHS.

In other words, the regression analysis was not influenced by YPLL scores in the general population, which may have resulted in a more precise predictive value of the YPLL for the PMHS under study. Findings from this study increase the sensitivity and specificity of mortality in the PMHS under study by providing a refined profile of individuals at increased risk. This is relevant for the needs assessment of persons served in the PMHS that are at higher mortality risk and for the implementation of initiatives that may improve the mortality risk among this population group.

The principal theme across manuscripts was the higher mortality risks experienced by individuals with mental illness who were served in a PMHS compared with decedents in the general population. Demographic characteristics such as gender, race, and age affected the excess and premature mortality among decedents served in the PMHS under study. This may require a diversified approach to mortality risk. It may be important to examine the crude impact of demographic factors on mortality risk when controlling for environmental, behavioral, and clinical factors.

The findings align with the ecoepidemiological life course framework as intermediate and proximal factors were statistically related with mortality as measured by the SMR, YPLL, and OR. While the distal factor was not statistically significant, it provided insights into the lifespan individuals with mental illness are expected to live once they leave the PMHS. Individuals with mental illness served in the PMHS under study died within 232 after discharge from the system.

The main unanticipated outcome was the overall SMR of 1.78 related to mortality risk particularly because the sample was mainly composed of Black decedents who in

general tend to have poorer health outcomes. Daumit et al. (2010) found a SMR = 3.7 in a sample on Medicaid recipients where 51% of decedents were Black. The lower estimate in the current study may suggest that perhaps the mortality risk faced by people with mental illness served in PMHSs may be decreasing.

Another unanticipated outcome was that when estimating the predictive relationship between mental illness and YPLL in Manuscript 1, males were found to be at higher mortality risk than females. However, in the predictive relationship in Manuscript 3, which excluded the influence of YPLL scores in the general population, females had higher mortality risk than males. The mixed result may be related to the proportion of females in the general population under study (77%) compared to the proportion of females served in the PMHS under study (45%) thus increasing the confidence of the predictive YPLL score in Manuscript 3.

There are several implications for positive social change that emerge from findings. Results from Manuscript 1 may help staff from the PMHS under study in understanding the actual mortality risk experienced by the population group served in the PMHS to prioritize resources and action. The results from Manuscript 2 may inform evidence-based practices that may improve health outcomes and impact the mortality risk due to unnatural causes of deaths. This risk may underscore the need at the PMHS under study for implementing evidence-based practices which target substance abuse. Results from Manuscript 3 provide insights into individuals who are at higher risk of premature mortality and may contribute to the planning and development of policies that decrease early deaths among individuals with mental illness served in the PMHS. Findings may

encourage solutions that will prolong the overall longevity of individuals served in the PMHS under study.

Due to limitations in data, exploration of mortality risks for decedents with specific severe mental disorders such as schizophrenia, major depression, or bipolar disorder was not possible. The categorization could have provided specificity about mortality risks by severe mental disorder for the population group served in the PMHS under study. The further exploration of mortality risks involving these disorders is necessary as findings may inform solutions to excess and premature morality. Finally, predictors of high mortality risks only accounted for 15% of the variance in YPLL scores, underscoring the opportunity of adding risk factors that were not available for the current study and that may increase the variance on YPLL.

There are at least two lessons that were learned through the integration of three studies that explored the mortality risk. First, a complex problem like mortality risk among individuals with mental illnesses who are served in the PMHS may require different approaches such as exploration of SMR, YPLL, OR, and causes of deaths. Findings from these approaches may increase the knowledge of the staff at the PMHS about mortality risks. The new knowledge may help staff prioritizing efforts to decrease the morality. Second, while three studies provide valuable information that could be applied at the PMHS under study to improve that mortality risk among the population group with mental illness, limitations in findings may constraint its applicability.

Conclusion

Persons with mental illness who are served in the PMHS continue to be affected by their mental illness in all aspects of their lives. The greatest impact of this public health problem is loss in life expectancy impacting the social and economic wellbeing of individuals, communities, and overall society.

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