The Prevalence of Multiple Comorbidities in Stroke Survivors in Rural Appalachia and the Clinical Care Implications

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Background: The majority of studies on multimorbidity have been in aging populations and there is a paucity of data on individuals following stroke. *Objective*: In order to better understand the overall complexity of the stroke population in rural Kentucky, we examined the prevalence of multimorbidity that impact the overall long-term health and health care for these individuals. *Methods*: A secondary analysis examined whether there are gender or age differences in this stroke population related to the prevalence of multimorbidity. A total of 5325 individuals, 18 years of age and older, seen at an academic medical center for the primary diagnosis of acute ischemic stroke or transient ischemic attack between the years of 2010-2017 were identified using the Kentucky Appalachian Stroke Registry. Descriptive analysis was used to report the prevalence of each comorbidity in the rural population by age group, gender, and level of multimorbidity by looking at concurrent frequencies. *Results*: Overall, hypertension, dyslipidemia, tobacco use, diabetes, and obesity were the comorbidities with the highest prevalence in our population irrespective of gender. Over 78% (n = 4153) of the individuals had 3 or more comorbidities while 61% (n = 3285) had at least 3 out of the top 5 comorbidities (hypertension, hyperlipidemia, tobacco, obesity, diabetes). With respect to age, 15% (n = 795) of the sample was under the age of 50, while 32% (n = 1704) were between the age of 50 and 64 and 53% (n = 2826) of the sample were 65 years or older. *Conclusions*: The results of this study indicate the majority of individuals affected by stroke in rural Appalachia Kentucky have multimorbidity. In addition, almost half of these individuals are having their strokes at a younger age, which will require a shift in the focus for therapeutic interventions (eg, reintegration into the workforce versus just community reintegration).

Key Words: Multimorbidity—chronic disease—rural—stroke

Introduction

People living in rural areas of Appalachian states, such as Kentucky (KY), suffer a disproportionate burden of negative health disparities. Various behavioral, health, and socioeconomic factors increase disability risk among rural Kentuckians. *Chronic health conditions* that are "disability risk factors" are heart disease and stroke, diabetes, peripheral artery disease, chronic obstructive pulmonary disease, cancer, depression, and cognitive impairment.[1] Heart disease and stroke, the 2 strongest disability risk factors, are increased in incidence in rural Appalachia compared to non-Appalachian regions.[2]

According to the United Health Foundation, KY ranks 43rd among all states for health indicators such as

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diabetes (46th out of 50), high blood pressure (47th), obesity (44th), smoking (49th), high cholesterol (49th), heart disease (48th), median income (45th), poor physical health days (49th), physical inactivity (46th), and 50th for preventable hospital readmissions (United Health Foundation, 2017). The Stroke belt is located in southeastern United States and represents the area of the United States with the highest stroke death rates. KY is located within the stroke belt and 26 Appalachian counties in eastern KY have some of the highest stroke incidence rates in the stroke belt. In 2017, KY ranked 45th among the states in stroke incidence in the adult population (United Health Foundation, 2017 www.americashealthrankings.org).

Smoking, hypertension, diabetes, cholesterol, and obesity are known risk factors for stroke that are increased in prevalence in KY compared to most other states.[3] Multiple studies have indicated multimorbidity, the presence of 2 or more coexisting comorbid conditions within a single person, is increasing in prevalence likely due to advances in life extending medical treatments and increases in life expectancy.[4-6] The higher levels of multimorbidity are associated with impaired physical functioning, poorer quality of life, increased frequency of use of health services, and higher risk of death.[4,7,8] However, the majority of the studies that have examined multimorbidity have been in the aging population; while there is a dearth of studies that have focused specifically on multimorbidity in the stroke population across age groups.

In order to better understand the overall complexity of the stroke population in the Central Appalachian region, the current study examined the prevalence in chronic condition multimorbidity in acute ischemic stroke (AIS) and transient ischemic attack (TIA). Additionally, this study examined the relationship between age, the prevalence of multimorbidity, and stroke.

Materials and Methods

Individuals with AIS and TIA were identified through the KY Appalachian Stroke Registry, using our previously published methods.[9] Briefly, the University of KY Healthcare clinical data set contains primarily health information for the inpatient population of all patients seen at the University of KY and currently contains data from over 554,300 individuals seen between 2006 to the present (for the purposes of the stroke registry, data starting in 2010 to the present is being utilized). This data warehouse contains the following data elements: (1) demographics (eg, age today, gender, marital status, race, etc), (2) provider level detail (services provided), (3) medical diagnosis (International Classification of Diseases, Ninth and Tenth Revision Codes; ICD-9, ICD-10), (4) medical procedures (inpatient facility and technical procedures; CPT codes), (5) lab tests and results (eg, chemistry, coagulation, hematology, urinalysis, etc), (6) medications received, (7) visit details (age at visit, length of stay, financial classification, service unit, weekend admission, etc), and (8) vital signs (eg, height, weight, BMI, direct arterial blood pressure, noninvasive blood pressure, heart rate, pulse oximetry, respiratory rate, temperature, death status, tobacco status, etc). Data filters were developed using the ICD-9 and ICD-10 codes listed (see Table 1 in our previous published report). Since this study was focused on individuals who live in rural communities, rurality was determined by the county of residence. This project was approved by the University of KY Institutional Review Board.

For the purposes of the present study, the variables that were examined included: gender, age, comorbidities (hypertension, hyperlipidemia, tobacco use, obesity, diabetes, coronary artery disease (CAD), atrial fibrillation (AFIB), chronic obstructive pulmonary disease (COPD), prior stroke, heart failure, and peripheral vascular disease (PVD). For diabetes both ICD-10 codes and Hemoglobin A1c (HBA1c) values were used. For obesity we calculated body mass index

Table 1. *Demonstrates the complexity of the individuals who have had a stroke related number of comorbidities. For example, someone who has diabetes is 5.8 times more likely to have 6-10 additional comorbidities than to only have 1-2 or only 5.1% of these individuals with diabetes had only 1-2 additional comorbidities*

% with only 1-2 comorbidities	# comorbidities	1-2	3-5	6-10	Odds ratio 95% CI and *P* value
5.1	Diabetic	121	1542	703	5.8; 4.7-7.1; $P < .0001$
8.1	Obese	164	1296	573	3.5; 2.89-4.22; $P < .0001$
8.7	Dislipidemia	321	2520	828	2.6; 2.24-2.97; $P < .0001$
11.3	Tobacco	282	1608	609	2.2; 1.8-2.5; $P < .0001$
14.0	HTN	629	3014	852	1.4; 1.2-1.5; $P < .0001$
1.0	PVD	3	147	159	53.0; 16.5-169.9; $P < .0001$
2.8	Heart failure	20	341	364	18.2; 11.3-29.2; $P < .0001$
3.3	COPD	30	463	403	13.4; 9.1-19.9; $P < .0001$
2.8	CAD	52	1119	698	13.4; 10-18; $P < .0001$
4.6	Prior stroke	41	527	316	7.7; 5.4-10.9; $P < .0001$
6.0	AFIB	66	644	385	5.8; 4.4-7.7; $P < .0001$
6.2	Average	157	1202	535	

(BMI) using reported height and weight. These comorbidities were selected since they are consistently reported nationally as part of American Heart Association/American Stroke Association's Get-With-The –Guidelines®- Stroke.

Subjects

A total of 5,325 individuals (2,595 females and 2,730 males), 18 years of age and older, seen at an Academic Medical Center for the primary diagnosis of AIS or TIA between the years of 2010-2017. All individuals survived their stroke and lived in a rural KY community.

Analysis

Descriptive analysis was used to report the prevalence of each comorbidity in the rural population by age group, gender, and level of multimorbidity by looking at concurrent frequencies. The prevalence was estimated by dividing the number of individuals with comorbidity by the sample size. With respect to relationship between having an existing comorbidity (eg, diabetes, hypertension, etc.) and no additional comorbidities or just one comorbidity versus having six or more comorbidities the odds ratios (OR) and a 95% CI were calculated.

Results

With respect to age, 15% (n=795) of the sample was under the age of 50, while 32% (n= 1,704) were between the age of 50 and 64 and 53% (n=2,826) of the sample were 65 years or older (Fig 1).

Overall, the comorbidities with the highest prevalence in our population were hypertension (84%), dyslipidemia (69%), tobacco use (47%), diabetes (44%), and obesity (38%) (Fig 2). In addition, a significant percentage of individuals had coronary artery disease (CAD; 15% of females and 20% of males). Males had a higher prevalence of tobacco use (55% versus 38%) and CAD (39% versus 31%) than females. Otherwise, there were no additional gender differences.

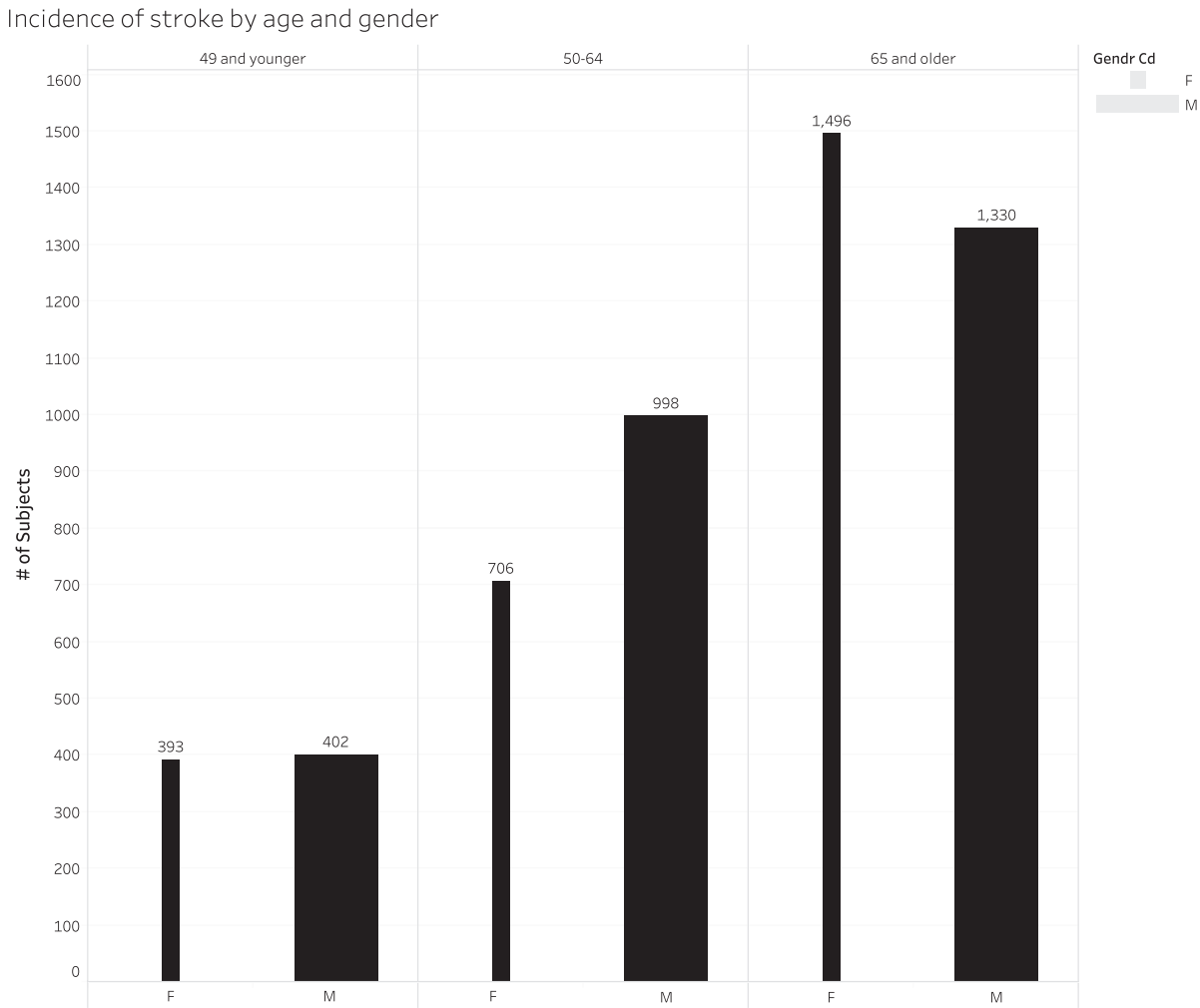

Figure 1. *Demonstrates the distribution of stroke by age category and gender. In the study population, the majority (53%) were over the age of 65. There was a higher incidence of stroke in males in the 50-64 age range, while more females had stroke over the age of 65.*

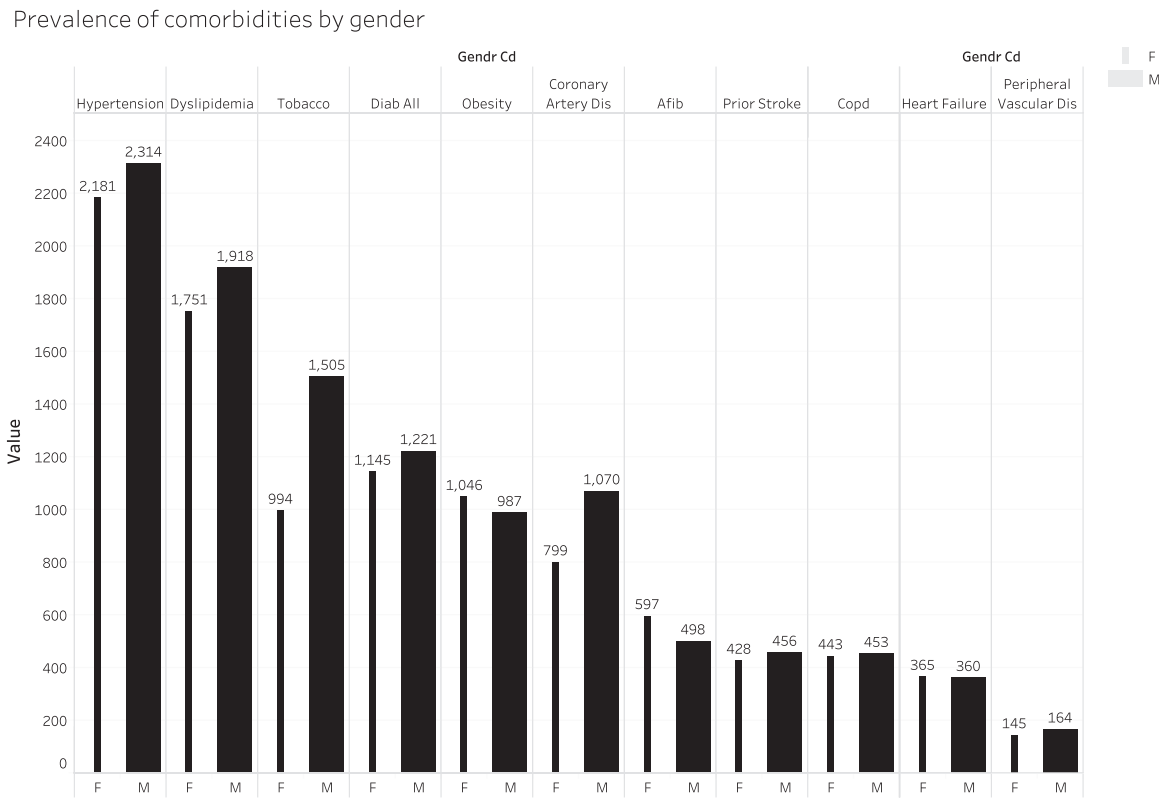

Figure 2. *Demonstrates the overall prevalence of each of 10 accepted stroke related comorbidities as well as the overall distribution related to gender. The 2 morbidities with the highest prevalence were hypertension (84%) and dyslipidemia (70%). Males had a higher prevalence of tobacco use and coronary artery disease.*

Because of implications on the overall medical management of these individuals, the primary focus of the study was on the prevalence of multimorbidity in this rural stroke population with respect to age. Over 78% (n = 4153) of the individuals had 3 or more comorbidities (Fig 3), with the largest number of individuals having between 3 and 5 comorbidities (21% had 3, 23% had 4, and 18% had 5 comorbidities).

The top 5 comorbidities (hypertension, hyperlipidemia, tobacco, obesity, diabetes) are all modifiable risk factors related to stroke. Therefore, we examined the prevalence of multimorbidity with respect to these modifiable risk factors in our sample. When we focused on these 5 comorbidities, 26% (n = 1,384) of the total stroke population had 2 of the top 5 while 32.5% (n = 1,733) had 3 out of 5, 22.7% (1,208) had 4 of the 5, and 6% (n = 349) had all 5 comorbidities (Fig 4). Overall 61% (n = 3,285) of the stroke population had at least 3 out of the top 5 comorbidities. There was no significant difference between males and females with relation to the severity of multimorbidity.

Multiple studies have indicated that age can have an impact on the development of comorbidities. Therefore, the number of modifiable comorbidities by age groups was also examined. We divided the stroke sample into 3 age groups; less than 50 years of age (n = 795), 50-64 (n = 1,704), and 65 and older (n = 3,826). There was a difference in the distribution when we look over the total 10 comorbidities with the under 50 group having more individuals with 2 comorbidities versus the 65 and older group (21% versus 12%) and the 65 and older group had a higher percentage with 5 or more comorbidities (19.5% versus 11.7%; Fig 5). In total, 13% of the under 50 group had 0-1 comorbidities versus only 5.5 % of the 65 and older group. Examination of the prevalence of each comorbidity by age group did show group differences. As would be expected there was an increase in prevalence with age in several areas (Fig 6). Over 87% of the individuals 65 and older age group were diagnosed with hypertension compared to 73% of the under 50 group. Over 72% of the 65 and older were diagnosed with dyslipidemia compared with 57.9% in the under 50 age group. Forty-two percent of the individuals in the 65 and older group were diagnosed with CAD compared with 16.9% of the under 50 age group. Finally, over 31% of the individuals in the over 65 age group were diagnosed with AFIB compared with only 4.5% of the individuals in the under 50 age group. Interestingly, there were 2 comorbidities that showed a downward trend with respect to prevalence. Over 61% of the individuals under the age of 50 were listed as using tobacco compared to only 35% in the 65 and older age group. In addition, over 49% of the under 50 age group were listed as obese compared to only 31% in the 65 and older age group. The distribution of

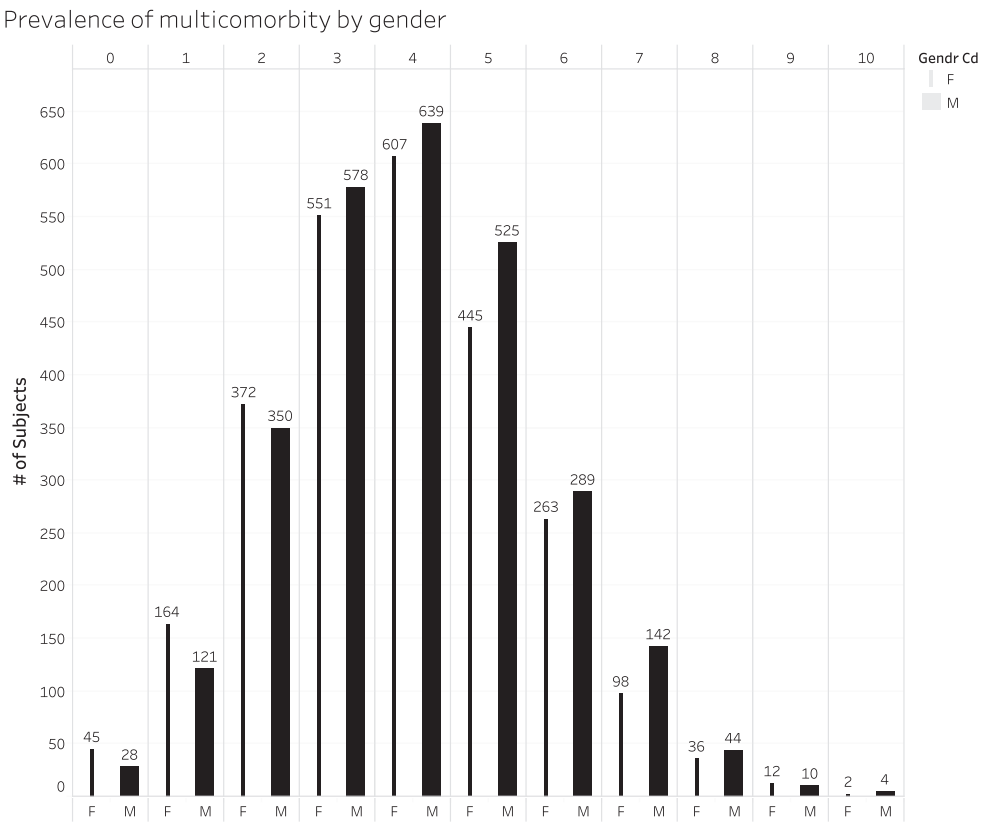

Figure 3. *Demonstrates the number of individuals with more than 1 comorbidity with respect to gender. Less than 2% of the population had no comorbidities and only 5% of the population had only 1 comorbidity. In total, 78% of the population had 3 or more comorbidities with 21% having 3, 23% having 4, and 18% having 5 comorbidities. There is no significant difference with respect to gender.*

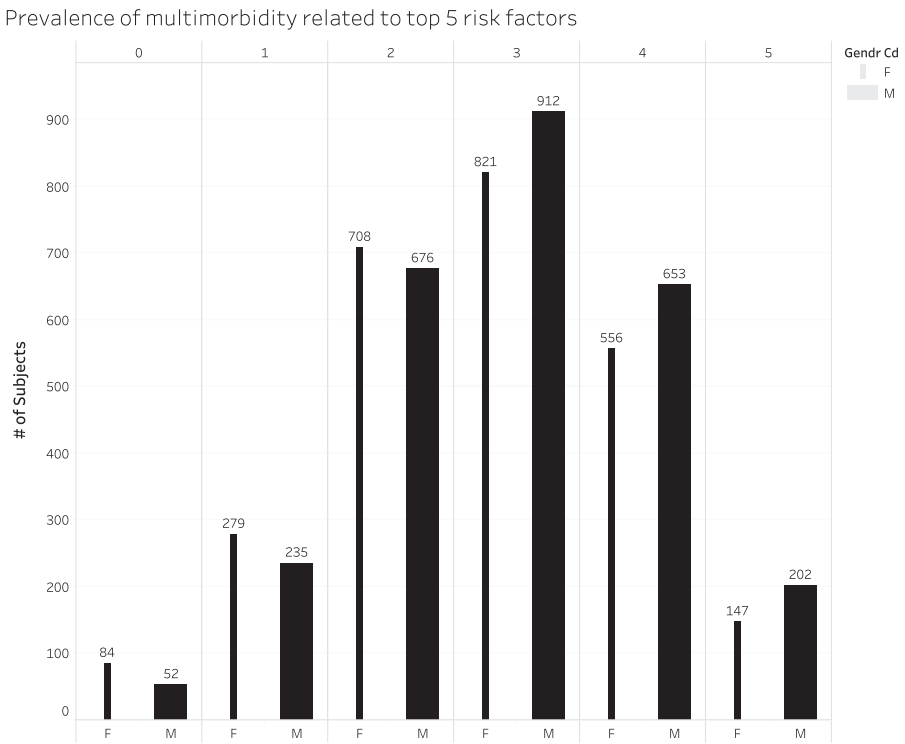

Figure 4. *Demonstrates the prevalence of multimorbidity related to the top 5 comorbidities (hypertension, dyslipidemia, diabetes, tobacco use, obesity) and gender. In total, 88% of the sample had at least 2 comorbidities, 62% had at least 3, and 29.5% had at least 4 out of the top 5 comorbidities. There was no difference in the prevalence of multimorbidity with respect to gender.*

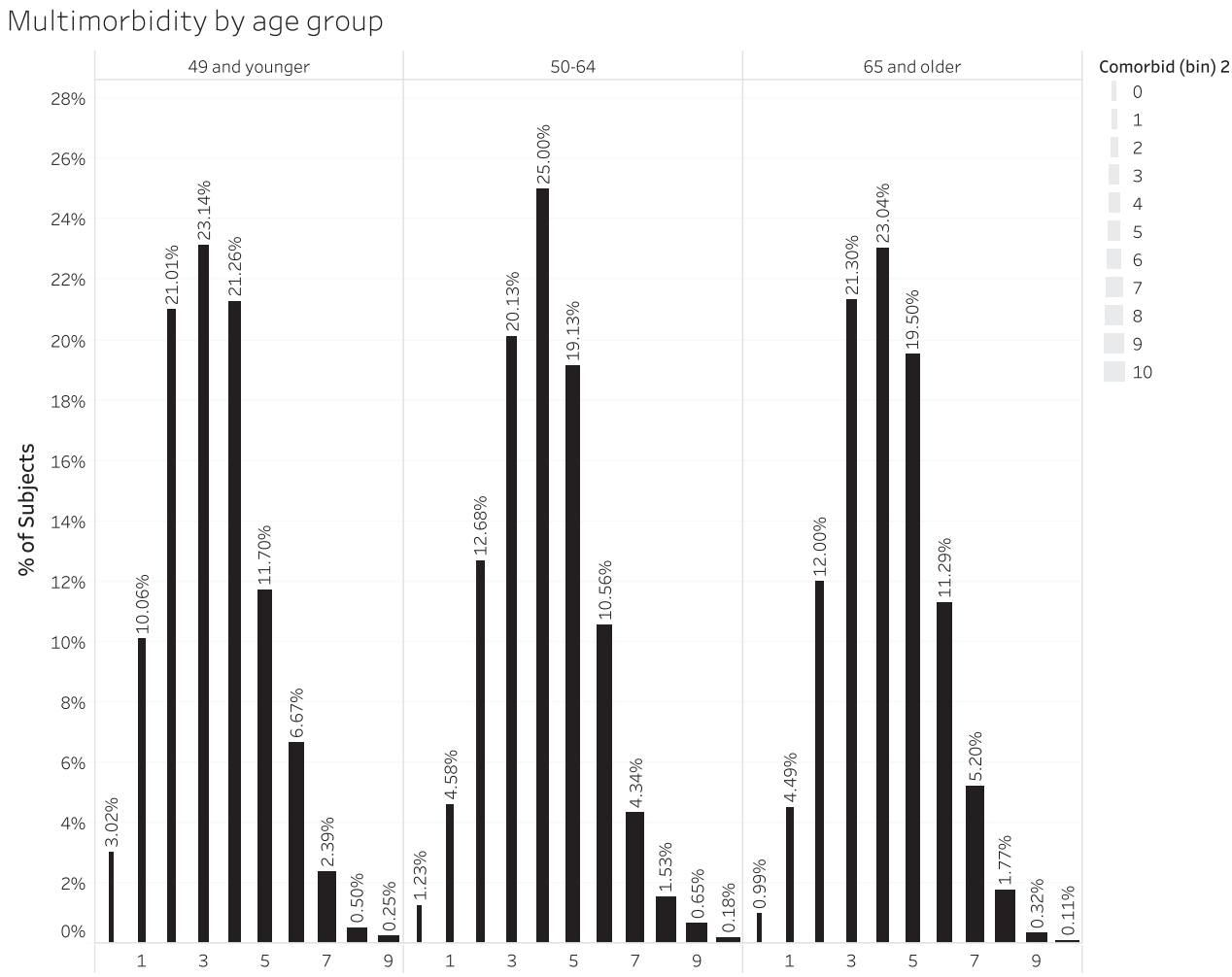

Figure 5. *Demonstrates the percentage of individuals with multimorbidity by age group. The under 50 group had a higher percentage of individuals with only 1-2 comorbidities compared to the other age groups. However, all of the age groups demonstrated a high incidence of multimorbidity.*

multimorbidity was similar between the 3 age groups when we focused on the top 5 comorbidities (Fig 7).

Finally, we examined the overall health of this population by examining the likelihood of having multimorbidity in addition to each of the individual risk factors. For example, a person who had a stroke and was diagnosed with diabetes was 5.8 times more likely to have 6 or more comorbidities than to have only 1 or 2 comorbidities. A person with AIS and peripheral vascular disease (PVD) was 53.0 times more likely to have 6 or more comorbidities than only 1 or 2 (Table 1).

Discussion

The results of the current study showed hypertension, tobacco use, and diabetes were 3 of the top 5 comorbidities. These results are similar to other studies.[10,11] The percentage of our population with each of these comorbidities is higher than previously published reports due in part to the high prevalence rates of all of these risk factors in the Appalachian region.

An important finding from the current study was that the majority of individuals affected by stroke in rural KY have multimorbidity. This follows the overall epidemiology within the region as assessed by the CDC and United Health Foundation, which consistently rank KY among the worst related to stroke risk factors.

Previous studies in the aging population have demonstrated an overall increase in the prevalence in multiple chronic conditions with increasing age.[11,12] However, the present study did not show this trend. In fact, the population under the age of 50 already demonstrated similar levels of multimorbidity (especially with respect to the top 5 modifiable chronic conditions) compared with the population over 65. This is a troubling result, since these are more likely to be working-age individuals who would be expected to live at least another 25-30 years. Returning to paid employment after stroke

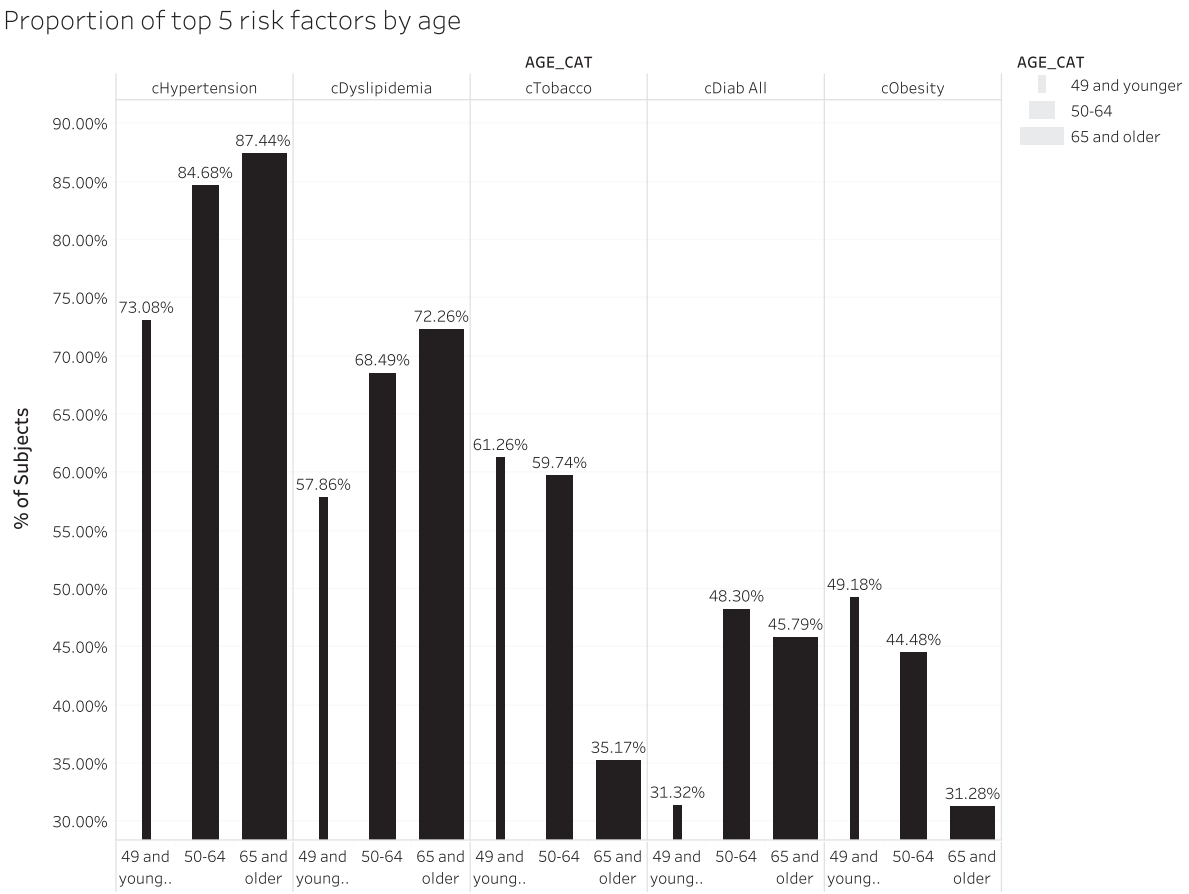

Figure 6. *Demonstrates the proportion of the top 5 risk factors across each age category.*

is often an important goal of rehabilitation. Rates of return to work following stroke are highly variable, but suggest numerous challenges for individuals to reintegrate back into the workforce.[13] Multimorbidity increases the economic burden of stroke, and the loss of job productivity as a result has societal implications as well as individual level effects.[14,15]

In addition to the high prevalence of stroke in working-age individuals, our findings also point toward the complexity of managing individuals with multimorbidity after a stroke. In studies in the elderly population it was shown that individuals with multimorbidity may be at a higher risk of receiving suboptimal care, inappropriate prescriptions, and experiencing potentially preventable hospitalizations.[5,16-18] A study by Yeh et al (2016),[19] demonstrated that patients with multimorbidity were less likely to receive inpatient rehabilitation during the first 7-12 months poststroke. And those that do receive inpatient rehabilitation often have worse functional outcomes than individuals with fewer comorbidities.[20] The information related to patterns of distribution of individual chronic conditions in the stroke population has important clinical implications. Individuals with stroke and their caregivers report barriers to receiving appropriate care, including inadequate time during clinician visits, lack of support from care providers, and difficulty juggling multiple providers and appointments.[21]

Boyd and Fortin (2010),[18] suggested that some co-occurring conditions may be managed synergistically, whereas other conditions increase the complexity of clinical care. The fact that the majority of individuals within this study sample (irrespective of age group) had at least 3 or more comorbidities would suggest that the overall population within this region are at substantial risk for a stroke and that prevention programs must look at a larger spectrum when developing new interventions. However, most clinical programs or guidelines for chronic disease management focus on specific and single conditions. This has led to a growing concern that these programs may not be sufficient or effective for individuals with multimorbidity.[12,18,22] A paradigm shift could be accomplished through multidisciplinary clinics for stroke survivors where multiple morbidities are addressed by experts in a single visit. A study by Schmid et al (2011)[23] demonstrated that a multidisciplinary stroke clinic resulted in incremental improvement in care quality for complex stroke patients with similar costs to traditional care. When working with individuals with chronic conditions, especially those living in rural communities, additional factors that would need to be accounted for include the presence of coexisting depression

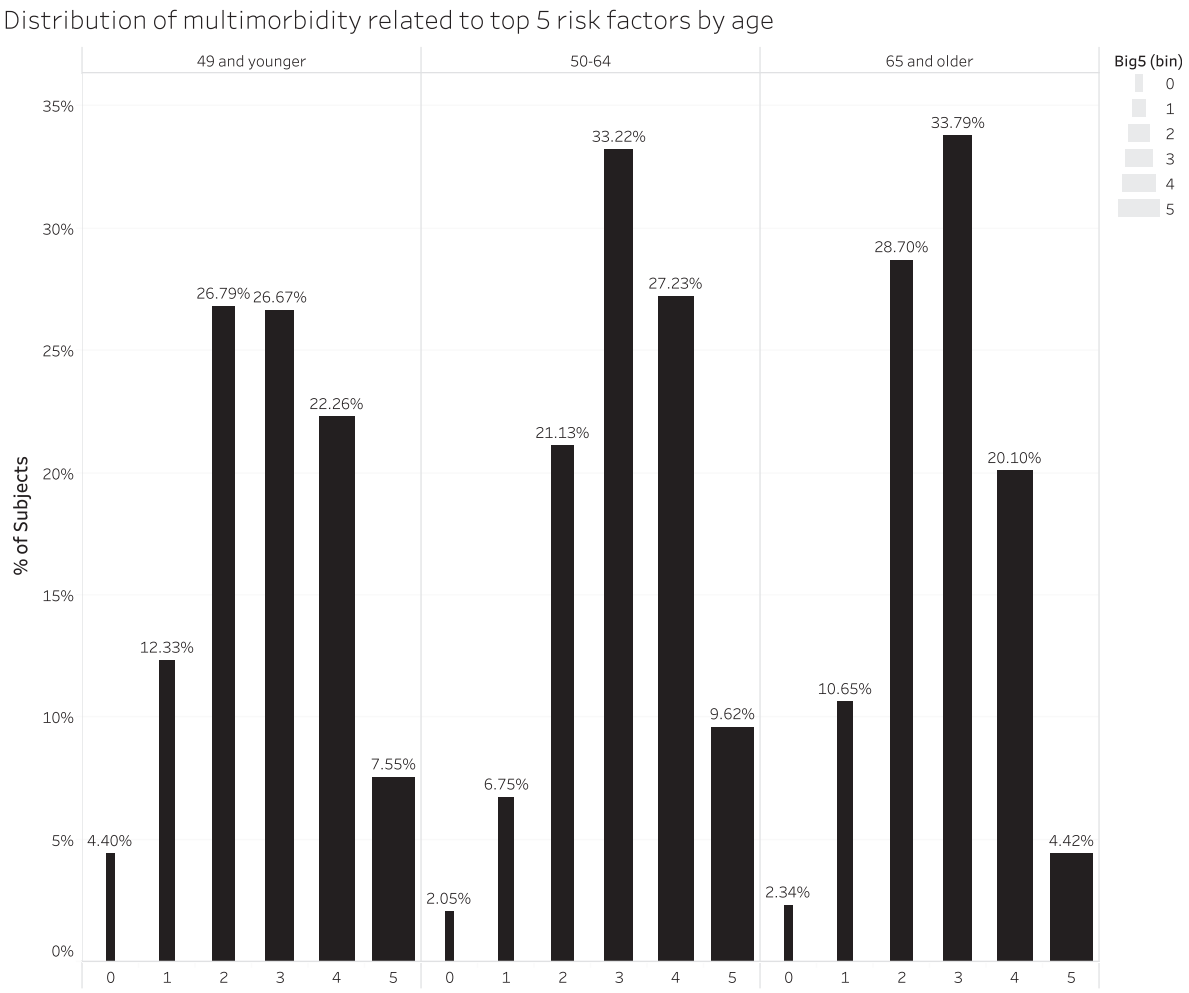

Figure 7. *The percentage of individuals with multimorbidity by age group related to the top 5 risk factors.*

and access to resources. Depressed subjects don't necessarily have much "buy in" to lifestyle modification, especially if the degree of depression is at a self-destructive level. Finally, access to essential resources is a key factor when implementing community-based programs. If the person cannot access resources such as medication, stable housing, healthy foods, caregiver support, then those programs are likely to have minimal impact.

Limitations

While the present study used an established stroke dataset, there are several limitations to the study. First, this is not a population-based study which means that the patient comorbidities reported could have been impacted by selection and referral bias. However, the hospital system that was the source of the database has as its catchment area eastern KY. In addition, the population in this study closely matches the overall population in Appalachian eastern KY (as well as Central Appalachian) that have well defined high levels of stroke risk factors and other comorbidities (CDC and United Health Foundation). Therefore, the study population is very likely to match the population as a whole within this region. Secondly, while this current study focused on the prevalence chronic disease multimorbidity, there are other important factors that have an impact on health. These include education level and caregiver support. Educational level is important in how well study participants are potentially engaged in the importance of the risk factor profile for stroke and how to address it. While education level is an important factor it is not typically found in large datasets because of the unreliability of this datapoint and therefore was not included in this study. Future implementation studies will need to account for patient and family education levels when establishing community-based interventions.

Studies have demonstrated the importance of caregivers, especially in rural communities, in effective community-reintegration of individuals poststroke.[24-26] Effective multidiscipline program must include caregivers and family as

key members of the health-care team for effective implementation of care transition plans to occur.

Conclusions

The results of this study indicate the majority of individuals affected by stroke in rural Appalachia KY have significant multimorbidity. In addition, almost half of these individuals are having strokes at a younger age, which will require a shift in the focus for therapeutic interventions (eg, reintegration into the workforce versus just community reintegration). This highlights the need for comprehensive prevention and management programs that are tailored to the specific needs of high-risk populations, such as individuals living in under-resourced rural areas.

Declaration of Competing Interest

The authors declare no support from any organization or other relationships or activities that could appear to have influenced the submitted work.

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