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Is Technology the key to prevention of falls among the elderly in rapidly aging societies? A case study of Kunming, China

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Abstract

As the aging society rapidly becomes more dominant in the world, there is a pressing need for different stakeholders to tend to the needs of the aging sufficiently. This is crucial in ensuring the robustness of the healthcare system as a whole; given that it can only be as strong as its weakest link. This study focuses on one of the areas of need of the ageing society: fall prevention.

Numerous studies have been done on interventions by the government, private entities, elderly people and their caregivers to prevent occurrence and recurrence of falls[1]. However, most of these have been carried out in the gradually aging high-income countries. There is still a wide gap in literature investigating falls among the elderly in LMIC with rapidly aging populations. This study aims to bridge this gap by documenting current fall interventions in Kunming, a rapidly aging society in China's Yunnan Province; while investigating the viability of using technology to facilitate fall prevention in the future. To achieve these objectives, 5 key informant interviews (KIIs), 1 focused group discussion (FGD), 1 quasi focused discussion, and a survey with 30 respondents were employed.

Data analysis reveals some fall prevention efforts by the government and individuals; and a gap in efforts by non-governmental entities (both NGOs and other companies). Inspired by this gap, this study investigates – and finds-compelling factors suggesting technology could be crucial in fall prevention in rapidly aging societies in LMIC.

Keywords

Public health, Health Sciences: General. Social Sciences: General

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Acronyms & List of tables and figures

WHO – World Health Organization

YHDRA – Yunnan Health and Development Research Organization

SIT – School of International Training

(GOe) - the Global Observatory for eHealth

LMIC – Low- and middle-income countries

KII – Key Informant Interview

FGD – Focused Group Discussion

NGO – Non- governmental organization

EKG -Electrocardiogram

ICT – Information Communication Technology

1 Introduction

1.1 Background on falls

According to the WHO, a fall is an event which results in a person coming to rest inadvertently on the ground or other lower level.[2] Usually, it is not as a consequence of the following: sustaining a violent blow, loss of consciousness, sudden onset of paralysis, or an epileptic seizure.(Kellogg 1987) Globally, falls are a major public health problem. An estimated 646 000 fatal falls occur each year, making it the second leading cause of unintentional injury death, after road traffic injuries. Over 80% of fall-related fatalities occur in low- and middle-income countries, with regions of the Western Pacific and South East Asia accounting for 60% of these deaths.[2]

1.2 Complexity of falls among the elderly

The demographic of people with a particularly high incidence of falls includes athletes, children and the elderly population[3] ;with the elderly population having a high susceptibility to injury in addition to the high incidence. As a matter of fact, in adults over the age of 65 years, falls are the leading cause of injury and death by injury.[4] The increased propensity to injury among elderly adults is attributed to a high prevalence of clinical diseases (e.g. osteoporosis) and age related physiological changes (e.g. slowed protective reflexes) that make even a mild fall highly dangerous.[5] More specifically, for people over the age of 65, a simple fall could mean morbidity, reduced functionality, premature nursing home admissions and in the worst-case scenario; mortality.[5] In addition, recovery from fall injury is often delayed in older persons, which in turn increases risk of subsequent falls through deconditioning.[5]

1.3 Risk factors for falls among the elderly

Risk factors for falls among the elderly can be broadly classified into three categories: intrinsic factors, extrinsic factors and exposure to risk. The following sections, as outlined by WHO[6], present potential risk factors in each category. It is important to note that falls often result from dynamic interaction of risk factors in each category.

1.3.1 Intrinsic risk factors:

- *A history of falls* is associated with increased risk.
- *Age*: the incidence of falls increases with age.
- *Gende*r: for the younger old, fall rates for men and women are similar, but among the older old, women fall more often than men, and are far more likely to incur fractures when they fall.
- *Medicines*: benzodiazepine use in older people is associated with an increase of as much as 44% in the risk of hip fracture and night falls. There is a significant increased risk of falling with use of medications such as psychotropics, class 1a anti-arrhythmic medications, digoxin, diuretics, and sedatives. With the expanding evidence base for medications in chronic disease management, the number of prescribed medications has increased. Risk is increased significantly if a person is on more than four medications, irrespective of type in all but one trial. The use of four or more medications is associated with a nine-fold increased risk of cognitive impairment and fear of falling.
- *Medical conditions*: circulatory disease, chronic obstructive pulmonary disease (COPD), depression and arthritis are each associated with an increased risk of 32%. The prevalence of falling increases with rising chronic disease burden. Thyroid dysfunction leading to excess circulating thyroid hormone, diabetes and arthritis leading to loss of

peripheral sensation also increases risk. The prevalence of cardiovascular related causes of falls in the general population is not known, but dizziness is common in fallers. Depression and incontinence are also frequently present in populations of fallers.

- *Impaired mobility and gait*: the decline in strength and endurance after the age of 30 (10% loss per decade) and muscle power (30% loss per decade) result in physical functioning dropping below the threshold where activities of daily living become difficult and then impossible to carry out – this can occur in early old age for those who have been sedentary most of their lives. When strength, endurance, muscle power and hence function declines sufficiently, one is unable to prevent a slip, trip or stumble becoming a fall. Muscle weakness is a significant risk factor for falls, as is gait deficit, balance deficit and the use of an assistive device. Any lower extremity disability (loss of strength, orthopedic abnormality or poor sensation) is associated with increased risk. Difficulty in rising from a chair is also associated with increased risk.
- *Sedentary behavior*: fallers tend to be less active and may inadvertently cause further atrophy of muscle around an unstable joint through disuse. Those cutting back on normal activities because of a health problem in the 14 days previous to fall are at increased risk. Those who are inactive fall more than those who are moderately active or very active but do so in safe environments. However, muscle function is so strongly associated with physical activity that it is hard to demonstrate that physical activity and loss of function have unique contributions.
- *Psychological status* - fear of falling: Up to 70% of recent fallers and up to 40% of those not reporting recent falls acknowledge fear of falling. Reduced physical and functional activity is associated with fear and anxiety about falling. Up to 50% of people who are

fearful of falling restrict or eliminate social and physical activities because of that fear. Strong relationships have been found between fear and poor postural performance, slower walking speed and muscle weakness, poor self-rated health and decreased quality of life. Fear of falling predicts falls at one-year follow-up, and vice-versa. Women with a history of stroke are at risk of falls and fear of falling. Taking four or more medications also independently predicts fear. However, many older people do not adequately appreciate their risk status.

- *Nutritional deficiencies*: a low body mass index suggesting malnutrition is associated with increased risk. Vitamin D deficiency is particularly common in older people in residential care facilities and may lead to abnormal gait, muscle weakness, osteomalacia and osteoporosis.
- *Impaired cognition*: cognitive deficit is clearly associated with increased risk, even at a relatively modest level (short of florid dementia). For example, five or more errors on a short mental status questionnaire, score
- *Visual impairments*: visual acuity, contrast sensitivity, visual field, cataract, glaucoma and macular degeneration all contribute to risk of falls as do bifocal or multifocal lenses. Multifocal glasses impair depth perception and edge-contrast sensitivity at critical distances for detecting obstacles in the environment. Older people may benefit from wearing non-multifocal glasses when negotiating stairs and in unfamiliar settings outside the home.
- *Foot problems*: bunions, toe deformities, ulcers, deformed nails and general pain in walking increase balance difficulties and risk of falls. Footwear is also important.

1.3.2 Extrinsic risk factors

The size of the impact that environmental factors have on the risk of falling among older people is uncertain. Some studies have reported that between 30% and 50% of falls among community dwelling older people are due to environmental causes and others that 20% of falls are due to major external factors (those that would cause any healthy adult to fall). Older people often have problems slipping or tripping, lacking good balance or righting mechanisms for preventing the fall.

Extrinsic risks include:

- *environmental hazards* (poor lighting, slippery floors, uneven surfaces, etc.)
- *footwear and clothing*
- *inappropriate walking aids or assistive devices.*

1.3.3 Exposure to risk:

Some studies suggest a U-shaped association, that is, the most inactive and the most active people are at the highest risk of falls. This reveals the complex relationship between falls, activity and risk. The type and extent of environmental challenges that an older person chooses to embrace interact with the person's intrinsic risk factors. One trial found that walking may increase the risk of falls, others found that increased physical activity was associated with a decreased risk of falls, but an increased risk of suffering a serious injury. It does, however, appear to be beneficial for those in residential care facilities to engage in moderate-to-high levels of activity with the use of a walking aid. Some activities seem to increase the risk of falls, either by increasing exposure to risky environmental conditions (slippery or uneven floors, cluttered areas, degraded pavements), acute fatigue, or unsafe practice in exercise sessions.

1.4 Fall Prevention Interventions around the world

All around the world, there are conscious efforts to educate the elderly on fall prevention strategies. This is often done through retirement programs, hospital initiatives and independent fall prevention programs. Often education comes in the form of classes which are offered at a fee cases such as *Fall Prevention Trainer*[7]. Educational interventions also involve organized activities to practically train fall prevention exercise. An example of this is *The Six-Step Balance Syste*m by *Fall Prevention Trainer*[8]. Hospitals for instance Johns Hopkins provide similar services through their program *Community Aging in Place—Advancing Better Living for Elders (CAPABLE)*[9]

Technology companies have also been widely involved in fall prevention. In the past, they have come up with shoes with inbuilt sensors which track foot movement and balance and transmit it to a warning system prior to the occurrence of falls. Examples of these companies include b-shoe[10] among others.

Tracking devices are also used in form of smartphones and smart watches by companies such as apple. Medical alert devices for instance the lively mobile and the lively wearable by an American technology company known as GreatCall[11]. Similarly, Australian Company iStoppFalls[12] has developed a similar medical alert system as the Lively products.

2 Methods

2.1 Ethics Statement

The initial protocol for this study was approved locally by the review board at Yunnan Minzu University. Protocol adjustments in the course of data collection were overseen by Dr. Jie, my culturally competent companion, translator and primary advisor. For Key Informant Interviews (KIIs), Focused Group Discussions (FGDs) and quasi focused discussions; consent was sought

verbally from participants prior to partial or full participation. As for the survey, a brief introduction of the project and principal researcher -myself- was included in addition to relevant contacts for any questions arising and assurance of anonymity.

2.2 Study Setting

The study was carried out in May 2019 in Kunming city, Yunnan Province, China. Kunming is a major city in China characterized by high population density, extensive housing in high rise buildings and broad transport and communication networks. The primary language of communication is mandarin.

About 4.2 million people reside in the city compared to 2.2 million in the remote areas of Kunming[13]. In terms of the age distribution of the resident population of Kunming, 15.5% are under 14, 72.41% are between 15 and 59, 12.09% are between 60 and 65 and 8.37% are more than 65 years old[13]. Kunming is therefore considered an ageing society by the WHO[14] as it satisfies the condition of having more than 10% of its population is over the age of 60, thus making it a prime setting to study fall prevention in a rapidly aging population.

2.3 Quantitative Data Collection

I administered a survey with both open ended and close ended questions (See Appendix A) to a sampling frame that included anyone who had elderly relatives in their families. I chose to include people who have elderly members in their family due to the prevalence of filial piety eff in my area of study. Summarily, the younger generation has an expectation to care for their elderly folks hence are heavily involved in decision making regarding the elderly people's health and well-being. This makes them instrumental in studying fall prevention interventions.

The survey was sent through WeChat[**] to 6 SIT teachers via the program coordinator, 12 members of SIT host families via their respective visiting students, 6 members of the weekly English corner[††] directly and 5 workers at Yunnan Health and Development Research Organization (YHDRA) via Madeline, an intern working there. A few people including Dr. Jie, my host mother Cindy, my teacher Xiao laoshi posted it to their individual WeChat moments where it was visible to their contacts: encouraging those who wiled to fill it. The survey was initially written in English and later translated into mandarin with the help of Dr. Jie.

Survey method was employed because most relatives of the elderly are busy with school or work and would barely make time for in depth interviews. Additionally, given the short timeline of the study, the survey method proved effective in collecting a substantial amount of data from different sources over a short period of time. Advantages aside, this study acknowledges the limitations of surveys as far as personal opinions spanning beyond the survey questions yet within the confines of the topic of study. As such, a final open-ended question on any additional comments was included.

Sampling of the population was mainly based on convenience. Snowball sampling was also utilized on a smaller scale in the case of participants who reached out to their contacts to fill the survey.

30 people ended up completing the survey, with some respondents filling details for more than one elderly persons. Effectively, 57 unique cases were recorded.

Due to the electronic distribution of the survey on WeChat moments[‡‡], it was impossible to determine the number of people who received the survey but did not respond to it. Response rate

[**] WeChat is a Chinese multi-purpose messaging, social media and mobile payment app with over 1 billion users.
[††] English corner is a weekly conversation club aimed at aiding Chinese people to practice speaking in English
[‡‡] WeChat moments display information to a person's contacts but does not guarantee that they will actually look at the information

could only be accurately calculated for members of English corner who received the survey during the last few hours when the survey was live. Out of 6 people to whom the survey was sent, only two responded hence a response rate of 33.3% was obtained. Some tried to text responses instead of filling the survey and thus were not counted. It is possible that they were not familiar with the process of filing and sending the survey. Another reason for the low response rate has been identified as an influx of commercial surveys and scam on WeChat; which turns potential participants off clicking on any type of survey.

2.4 Qualitative data collection

I conducted 1 focus group discussion (FGD) composed of 3 people, 2 quasi focused discussion composed of 4 people in total and 5 key informant interviews (KIIs).

The FGD initially composed of a random sample of 3 men and 2 women at Green Lake park who were over the age of 65; but due to attrition in the course of the discussion, the group ended up with 3 male participants. This attrition was later discovered to be as a result of the cultural phenomena of *shuō Cáo Cāo Cáo jiù dào*. It can loosely be translated to the English saying, *speak of the devil and the devil appears* and it is taken seriously especially among the traditionalist elderly people. This deeply rooted belief saw a second attempt at an FGD turn out unsuccessful. A group of men spectating Chinese chase turned down our request to talk; and as we walked away they could be heard retorting how disrespectful of us to ask openly about such a bad thing as falls. This incident coupled with earlier attrition was a cultural epiphany for my middle aged culturally competent companion; and a signal for us to alter our approach. While the FGD was an optimum method to study a collective outlook where the demographic of interest

would check each other's accounts, the cultural oversight rendered it ineffective. Soon after we started, it was clear that we were not going to get data at the expense of the elderly's beliefs. We switched to quasi discussion groups where we talked to 2 random groups comprising of an elderly person using a walking aid and their caretaker. This approach worked better as people who used walking aids had likely experienced falls and were more open to discuss the topic. We inquired their reason for using walking aids, to ascertain cause, then proceeded to discuss falls. Through the quasi discussion groups, the participants were able to tap into their personal experience of falling to inform the study. Some limitations of this method of data collection include limiting the scope of data collected to prevention of recurrence of falls excluding prevention of initial occurrence. Other tools quantitative tools were used to close this gap.

KIIs were conducted at the offices of the respective participants as follows: Doctor Wang at Yunnan Province Number 2 People's Hospital, staff of the Rehabilitation Center at Yunnan Province Number 1 People's Hospital, Apple staff at Apple offices in Wangfujing, Xiaomi staff at Xiaomi offices in Wangfujing and Huawei staff at Huawei offices on Zhengyi Road. The informants were chosen based on expertise in the fields of healthcare and technology. The sessions lasted around 1 hour.

All FGDs, quasi discussion groups and KIIs were semi-structured, open ended and probing. (see appendix A) All questions were written in English then orally translated into Chinese during the execution with the help of Dr. Jie. For the FGD, quasi discussions and KII with Dr. Wang, the sessions were recorded on phone to be transcribed later and then destroyed. Permission to record was sought from the participants. For the rest of the KIIs, data was collected through note taking and no recording was done.

2.5 Data Analysis

For qualitative data, an inductive approach was applied to the framework method to analyze collected data. First, the recorded data was transcribed. The transcribed version together with notes from interviews were coded iteratively in the light of the research objectives. Through this repeated process of coding, novel themes and concepts constantly emerged thus, the thematic framework was systematically applied to all the data. The different thematic sections were coded using a numerical index system. At the end of the analysis, various themes were collected under three key subjected areas: Local background of falls among the elderly (in Kunming), local fall prevention interventions and investigating technology as a viable tool for fall prevention in Kunming

For quantitative data, descriptive analysis was carried out first. In this initial step, percentages, mean and median were calculated. In the later phase, inferential statistics is employed in the form of correlation and analysis of variance.

3 Results

3.1 Background of falls among the elderly in Kunming

3.1.1 Epidemiology

Different informants from the medical field acknowledge that falls are a concern among the elderly in Kunming as evidenced by the medical cases they encounter on a day to day basis. This urgency was reiterated by the survey in which out of the 30 survey participants, 25 had to deal with their elderly relative's fall at least once, giving falls an 83.3% incidence ratio.

Medical professionals and caretakers of the elderly acknowledge that there is widespread fear of falls independently and illnesses that come with effects such as falling. Among the caretakers,

80% indicated that on a scale of 5, their anxiety on the elderly relative falling was 5. 6% ranked the urgency at 4 out of 5 and 14% ranked it at 3 out of 5.

"...people fear cardiovascular diseases -which is a risk factor for falls-, so they do not go to the hospital when something is wrong. They do not know what vital signs to look for"

Distribution of the incidence of falls reported showed no gender pattern according to expert doctors. Males and females have roughly the same rate of incidence. In terms of age, incidence increases with increase in age. The median age recorded from the survey was 75.1 with a Standard Deviation of 7.1.

Common causes mentioned during KIIs were highly dependent on the specialization of the doctors. From a cardiology stand point, blood pressure and disorders of the nervous system comprised majority of the causes of falls while from rehabilitation point of view; factors such as vision, muscle power, gait and balance played a huge role. These common causes of falls were reiterated by caregivers in the survey. The survey results saturated the following causes:
High Blood Pressure, poor vision, insufficient muscle power, poor gait and balance, disorders of the nervous system and advanced age.

3.1.2 Sociocultural Scene

High social engagement was observed among elderly adults. This was characterized by public participation in song, dance, Taiji and gaming activities in the public parks. In addition, active involvement in grandchildren's daily life was observed. This was done through taking school going children to school and casual walks with toddlers and younger children. From the interviews, social engagement was prominent through social media apps i.e. WeChat.

As mentioned before, the cultural phenomena of *shuō Cáo Cāo Cáo jiù dào* (speak of the devil and the devil appears) cannot be ignored. In addition to challenging the success of this study, it inevitably implicates open communication on grave issues such as falls. This is seen in the awareness or lack thereof (Table 1) of interventions that individuals can take part in to prevent falls.

Finally, whether people would be willing to help an elderly person or not in this culture is a key component when discussing falls. In other parts of China, good Samaritans have found themselves on the wrong side of the law when the elderly person they helped accused them of causing the fall. In Kunming, however, this does not seem to be the case. KIIs revealed that in the age of technology, phone recordings or even CCTV footage while helping anyone who had fallen was readily available thus being falsely accused was not really a preclude to helping elderly adults who had experienced falls. Responses from the survey indicate 3 cases where good Samaritans indeed helped out in the event of falls and even called the elderly's next of kin

3.2 Local Interventions

3.2.1 By the Government

The government has, through its hospitals, established new targeted departments to deal with fall related recovery in order to prevent recurrence of falls. This is evidenced by the establishment of a physiotherapy department in Yunnan Province Number 2 People's Hospital in 2015 which includes a Rehabilitation Center. At the rehabilitation there was a specialized gym aimed at training muscular strength under controlled conditions e.g. reduced gravity to nurse those recovering back to strength in order to enable them to re-engage in physical activity.

In addition to the targeted marketing, programs have been developed to train physicians from different departments on matters pertaining falls especially among the elderly. Usually, such

programs are a career development tool. These programs are administered regularly by the physiotherapy department and doctors are required to pay a small attendance fee to attend the sessions. Free trainings are also offered for the elderly to take part in fall prevention lectures as well as other health enhancing education programs. Often times, attendees are either other inpatients or recently discharged patients.

Apart from the education programs, outreach programs are utilized. In such programs, doctors are required to leave the hospital every so often and go to housing communities to perform routine checkups on the elderly.

Finally, specific tests have been included in regular checkups for the elderly. This include the worldwide acknowledged Morse scale which is an essential tool in determining fall risk. At the Rehabilitation center, at least one patient on each floor undergoes the complete test in the presence of a group of doctors and nurses. While this is representative of only a fraction of the elderly population that needs said test, it is understandable due to low doctor patient ratios.

3.2.2 By Private Entities

There is a dearth of non-governmental organizations working on fall prevention in Kunming. Not one NGO working in this critical area of need could be identified. A search for any entities doing work that modifies risk factors for falls thus preventing falls lead to technology companies. Three companies interviewed in the study had a range of hardware that promote physical health thus preventing falls. These range from smart phones to smartwatches and health bands. For health bands, the prices ranged from prices ranged from 150-300 Kuai. Smartwatches ranged around 2000 Kuai for the cheaper options and upwards of 3000 Kuai for the more expensive options. Phones were observed to cost from 3000 Kuai onwards. The hardware is important because it provides the skeleton on which health apps are installed to foster wellbeing.

Software with different capabilities were explored during the interviews.

One main factor was an alert system during a fall. Latest technology provides accelerometer within the hardware which automatically detects a fall and prompts the phone to automatically call for help unless an individual opts out and cancels the call. This was seen in apple devices which also store crucial information like blood type and basic history of cardiovascular health in an SOS[§§] both of which come in handy in an emergency situation. Huawei and Xiaomi have almost similar products, except with no accelerometer. Instead of the automatic call, an individual can alert emergency services by initiating the emergency call via shortcut e.g. pressing a button several times.

In addition to the alert system, wellness apps are available to track physical activities. Through Xiaomi's health band for instance, users are able to determine BMI, body weight, body fat, hydration, bone weight, basic metabolism. They can then compare such vitals to the recommended range and detect any unhealthy trends. While these will cause a falling incidence only indirectly, doctors have through KIIs emphasized the importance of physical exercise and proper diet for which body fat, weight and basic metabolism are indicators. By closely monitoring said vitals, elders would be reducing the risk of falling. Both Huawei and Apple have similar functions. However, one important function that apple offers: EKG[***], is not available to users in China. This function is key in monitoring electrical activity thus is key in preventing heart-related falls.

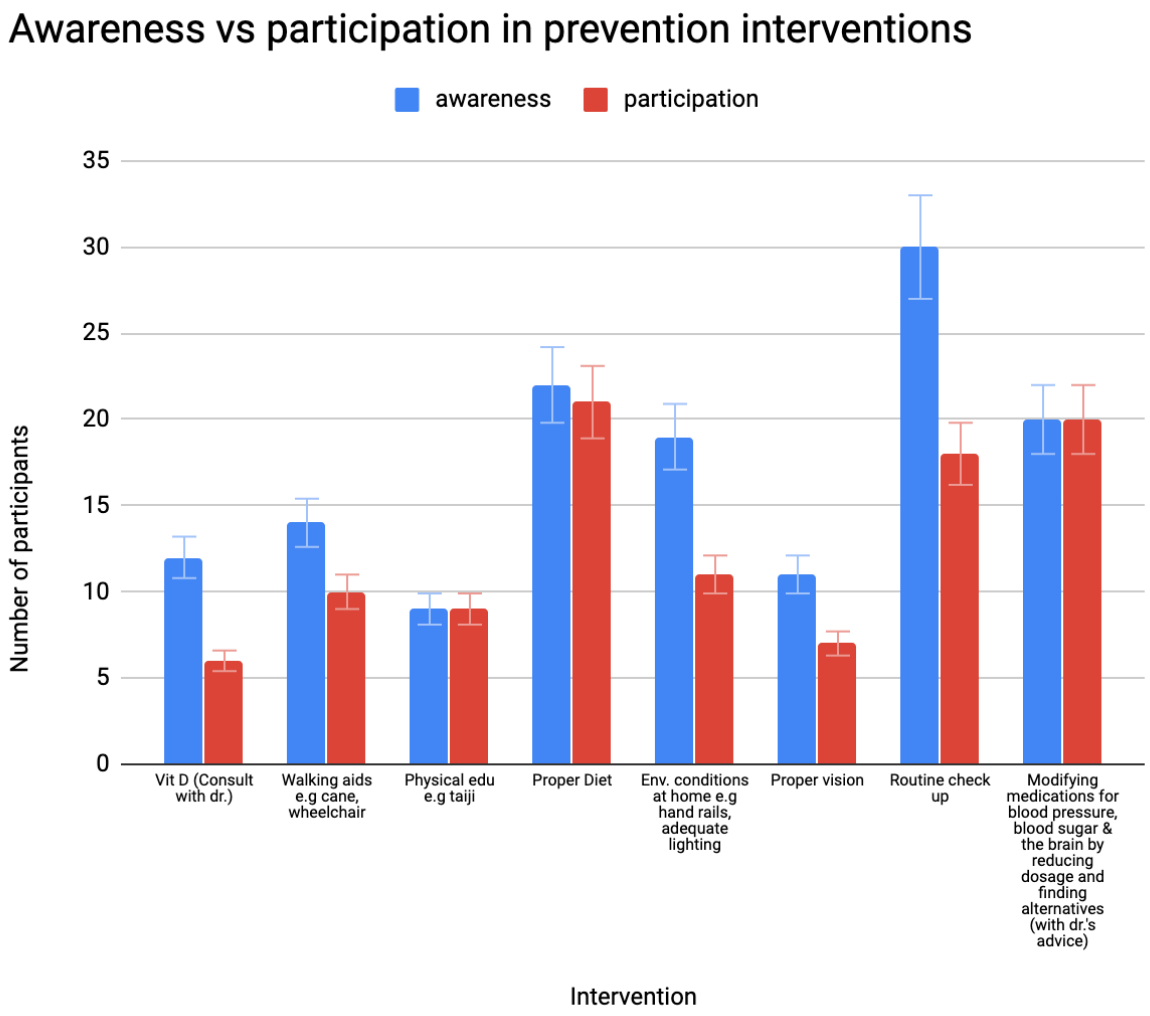
3.2.3 By Individuals

Several strategies have been scientifically proven for prevent falls. The graph below shows awareness versus participation as evidenced by the survey results.

[§§] SOS is an international code signal of extreme distress

[***] EKG Stands for electrocardiogram. It measures the electrical activity of the heartbeat.

Table 1



3.3 Viability of mhealth[†††] as a fall prevention tool in Kunming

From the findings from the local interventions, it was hypothesized that technology could play a key role in fall prevention. This hypothesis was made in the light of the sociocultural environment, stress on healthcare department and absence of other non-governmental players.

[†††] Mhealth is the use of mobile and wireless technologies to support the achievement of health objectives. It is a component of ehealth – the use of ICT for health.

The hypothesis was put to test by asking caregivers leading questions on falls that they experienced in their elderly relatives. The following results were obtained:

How was the participant informed of the elderly's fall?	Telephone	15	60%		
	Orally	8	32%		
	Both telephone & orally	1	4%		
	Never informed officially	1	4%		
Was the elderly person alone during the fall?	Alone	19	76%		
	Not alone	6	24%		
Who informed you of the fall	The elderly	14	56%		
	Another person known to the participant	9	34%		
	Other unknown person e.g. good Samaritan, police	2	8%		
How soon were you informed	Within an hour	13	52%	Through telephone	8 (62%)
				Through other means	5 (38%)
	Within a day	7	28%		

	Later than a day	3	12%
	Not at all	1	4%
	No answer	1	4%

70% of the elderly whose relatives filled the survey are reported to have smart phones. Among those that own phones, 67.5% would use an app with features related to fall prevention while 32.5% would not. Of those who would use it, majority would be willing to pay between 5-10 Kuai per month for the app. A few would like such an application to be free while a small majority would be willing to pay a small fee only per incidence of a fall where the app becomes of use. Among the 30% who do not own phones, only 5.8% would use an app with features related to fall prevention.

86.7% would buy wearable technology for their beloved elderly in the form of a wearable watch or a health band. Between the two the health band was preferred by 23.8%. About 50% would pay 100 -999 Kuai, 27% would pay upwards of 1000-2000 while about 30% would use said technology if only it were free.

These prices were observed to fall squarely within current market prices of said devices in local technology companies Huawei and Xiaomi.

4 Discussion

4.1 The effect of culture of silence in fall prevention.

A major finding from the study is the specific role of the local culture in attitudes towards fall prevention conversations. It is important to explore this since cultural competence has long been identified as a crucial determinant of success of global health interventions by other scholars.[15]

This study has found that the culture of silence seen through the cultural concept of *shuō Cáo Cāo Cáo jiù dào* acts as a barrier to open conversation around falls among healthy elderly adults. This phenomenon of the culture of silence is not a new global health. Studies have found this challenge while tackling other 'taboo' topics in different fields for instance reproductive health. [16]Silence is known to prohibit individuals from seeking treatment for embarrassing health conditions and in this case engaging in conversation to raise awareness on preventing occurrence and recurrence of falls.

In this study, the reluctance to speak has been associated with keeping 'bad luck' at bay. This is a superstitious claim as there is no science to back it up and as with all constructs of the mind, it can be shaped to cease being a disadvantage. As seen in the quasi focused groups, inclusion of survivors of falls in the conversation resulted in an open dialogue. This indicates that talks can indeed work to albeit in a non-conventional way by involving the survivors as well as healthy elderly adults in talks.

In the beginning of the study, it was expected that some cultural factors would impact fall prevention strategies in Kunming but the culture of silence, specifically, was not foreseen. Any future educational interventions must therefore be done with the cultural phenomenon of *shuō Cáo Cāo Cáo jiù dào* in mind in order to be successful.

4.2 Matter of lifestyle

With the global shift from infectious diseases to non-communicable lifestyle disease, it was anticipated that lifestyle choices play a significant role in falls among the elderly. This hypothesis was confirmed in the study findings where a significant number of causes were related to lifestyle diseases. While some risk factors were non-modifiable, majority of them have

could have been modified by proper diet and physical exercise. This lifestyle angle provides an opportunity for integrated prevention care where prevention strategies related to other lifestyle diseases seamlessly integrate fall prevention benefits of a healthy lifestyle. In a unique way, this merge may provide a way to bypass *shuō Cáo Cāo Cáo jiù dào* by having falls be a peripheral topic of conversation in a larger health conversation.

4.3 Is mhealth technology a viable tool for fall prevention in this rapidly aging population?

A recent survey by WHO revealed a groundswell of activities in mhealth. The whole world is experiencing a seismic shift in health management. Even in China, telemedicine has taken off with studies showing that it is indeed effective[17]. Therefore, use of mhealth in fall prevention is a natural subsequence.

From the study, a powerful combination of factors is in favor of mhealth for fall prevention emerge: high access of mobile technology, increased market among the rapidly aging, rapid advances in mobile technology and applications, willingness of the market to try using mhealth for fall prevention and competing priorities for traditional healthcare resources i.e. hospitals and doctors.

Access to mobile technology is widespread as seen in the high rate (70%) of phone ownership among elderly adults in Kunming. This can be explained by the affordability of mobile equipment due to an increased supply from different technology companies. When there are many competing suppliers, the consumer wins. And in the process of claiming market share, technology companies compete to outdo each other in terms of the quality they produce. Consequently, the high ownership ratio is combined with rapid advances in mobile technology and apps. These advances are clear as in the result section where, various companies have a

variety of hardware and software from phones, smartwatches, health bands and applications to serve different categories of mhealth i.e. emergency toll-free telephone services, reminders (for physical exercise, appointments etc.) With the necessary push, the elderly will be educated on how to use current tools, and more specific elderly friendly ones will be developed. And the incentive for such developments does exist in an increasing elderly population since the society is rapidly aging.

Since most of the government interventions in the result section are new, they still lack a capacity to serve majority of the population. And while rapid expansion may be needed, other pressing needs in the healthcare system may inevitably come first. The trend is similar when it comes to human resource: they have been found to be insufficient and even if Kunming trained more health practitioners, the sustainability may not be possible. Coupled with the willingness to try different technology from the survey, mhealth is surely the way to mediate the problem of falls.

Finally, technology is a handy factor in bypassing the culture of silence. Through community mobilization and health promotion monitoring, it is possible to enhance education without actually ‘speaking’ about any bad omens'

Indeed, there may be some disadvantages like the burden of training the elderly populations, the high cost of some technology. However, the advantages greatly outweigh the disadvantages.

5 Conclusions and Recommendation

This study aimed to understand fall prevention interventions in Kunming. Results have shown that falls among the elderly is a public health concern at that there are some local interventions at government, private entity and individual level. A dearth of information on action of private

entities led to the question “Can technology be used as a tool in fall prevention?” and through both qualitative and quantitative inquiry, a set of powerful factors in favor of the use of technology have been identified. Summarily, they are high access of mobile technology, increased market among the rapidly aging, rapid advances in mobile technology and applications, willingness of the market to try using mhealth for fall prevention and competing priorities for traditional healthcare resources

Further market research and training of elderly is necessary for technology to be at the forefront of fall prevention in Kunming.

Limitations of this study

The sample used in this study is biased as it was based on convenience. Therefore, this study is in by no means representative of Kunming city.

In addition, the crucial voice of the elderly population was minimized by the unsuccessful FDGs. While conducting quasi focused groups ensured the opinions of the elderly were not left out, a more data reflecting the elderly population’s sentiments would be crucial for an all-round view of falls among the elderly.

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7 Appendix A

7.1 Survey: Middle aged folks (30-55) taking care of their parents

Are there any elderly members in your family (older than 65?)? If yes could you, please help me to answer the following questions for a school project. I am an international student at Yunnan Minzu University and would be very grateful if you could help! Call me on 13064255447 if you have any questions! The survey is completely anonymous, so your privacy will not be interfered with

1. How many elderly folks are there in your family?
2. How old are they respectively?
3. One of the major challenges of aging is falling. Have you seen this problem among your parents or any elderly folks in your family? (Yes, No)

   FOR THOSE WHO'VE HAD FALLS (This section be automatically skipped if no falls observed)
4. How old were they when the fall happened?
5. Have you observed multiple falls in a short span of a day or two? (Yes, no)
6. Have the falls happened regularly over a long period of time i.e. a few months? (Yes, no)
7. Who informed you of the fall?

8. How soon were you typically informed?
9. How were you typically informed of the fall(s)?
10. Were they willing to go to the hospital after the fall?
11. Did they go to hospital to find out the medical cause of the fall? (Yes, No)
12. If they went to the hospital, what was identified as the cause of the fall?
13. Were they alone when the fall happened? (Yes, No)

BOTH THAT HAVE HAD A FALL AND NOT

14. On a scale of 1-5 where 5 is very concerned, how anxious are you about them falling and harming themselves in the future?
15. Are you aware of the following generalized scientifically proven methods that can prevent falls? (Yes or no for each method)
    - Vitamin D (consult with dr.)
    - Walking aids e.g. wheelchair, walking sticks
    - Physical exercise e.g. Taiji
    - Proper Diet
    - Environmental modifications in the home e.g. rails, adequate lighting
    - Proper vision
    - Routine check up
    - Modifying medications for blood pressure, blood sugar & the brain by reducing dosage or finding alternatives (with dr. advice)
16. Does the elderly person use any of the following generalized scientifically proven methods that can prevent falls? (Yes, not sure, no for each method)
    - Vitamin D
    - Walking aids e.g. wheelchair, walking sticks
    - Physical exercise e.g. Taiji
    - Proper Diet
    - Environmental modifications in the home e.g. rails, adequate lighting
    - Proper vision aids
    - Routine check up
    - Modifying medications for blood pressure, blood sugar & the brain by reducing dosage or finding alternatives (with dr. advice)
17. Does the elderly adult have a smartphone? (Yes, no) Which brand?
18. Would you encourage the elderly person to download an app that can be used to prevent and predict falls on their phone (with advice from a doctor) (Yes, No)?
19. Would you be willing to pay said app? (Yes, no)
20. If yes, what is the maximum amount you would pay per month (self-input amount)
21. Would you buy a wearable sensor e.g. a smart watch or a health band?
22. Would you want the wearable device to alert emergency services or correspondent contacts?
23. How much would you be willing to pay for said wearable?
24. Would you prefer a smartwatch or health band or either?
25. Do you have any additional comments?

7.2 Semi-structured questions for (KIIS): Tech. Company Officials

a) Background: Company Background
b) Tell me about your wellness software, hardware
c) What is the financial cost of said hardware and software
d) Tell me about your services -either apps on your phone or smartwatch- that aid in falls among the elderly.
e) Fitness? Alerts? Directly calling emergency services
f) Details of how each work
g) How many people use said service?
h) What kind of feedback do you have on the service?
i) Is the company ready for widespread use of the service?
j) Are medical professionals involved in the design and execution?
k) What is the accuracy?

7.3 Semi-structured questions for (KIIS): Doctors

1. From a (specific specialty) perspective what do you think causes falls among the elderly?)
2. What can be done about these risk factors?
3. Is there a sense of awareness among your patients on what to do to prevent falls or what to do immediately after falling? (Public education)
4. What should one do after a fall? (In this setting – Kunming, China)
5. How should one help someone who has fallen? (Member of public, given previous cases of false accusation)
6. What is the common frequency of falling (due to cardiac issues or otherwise) for different age groups and genders? (Observed in this hospital?)
7. What is the risk (situations or places) for falls among the elderly? hospitals, at home, in the park…
8. What does the treatment journey look like for people who have fallen? (Other than treatment for injuries what else do you offer them? Fall prevention lessons…)
9. Do you prescribe walking aids? What's the response to that?
10. Have you seen a trend in the occurrence of falls in the past 10 or 20 years?
11. Do you work with other centers that deal in prevention of falls?
12. During checkups, do you perform checkups that can indicate risk of falling for instance walking tests to check gait etc.
13. Opinions on use of technology
14. What does a routine checkup for an elderly entail? Can we have a look at the process in action?

7.4 Semi structured questions for (FGDS) Elderly Folks in the park

1. Background: Setting where we meet them, age, gender, work, education, where they live
2. What does aging mean to you?
3. Do you go for checkups?
4. How regularly?
5. Are you satisfied with how the checkup is done?

6. Some challenges with ageing include falling, have any of you experienced falling?
7. How often?
8. Have you observed any trends (e.g. different frequency when on medication, or as you get older, when standing up)?
9. Is there a particular place in the environment where you tend to fall/slide for example while standing up etc.?
10. Who was the first person you told when you fell?
11. What did you (or would you) do after the fall? Did you figure out why you fell? Hospital? Why or why not? TCM or Western?
12. Have your peers/family visited you after you fell (Have you visited your peers in case they've had a fall)
13. Have you been informed of the following tactics to reduce falling? Do you participate in any of them? If you're aware but don't use them, why not?
    - Vitamin D (consult with dr.)
    - Walking aids e.g. wheelchair, walking sticks
    - Physical exercise e.g. Taiji
    - Proper Diet
    - Environmental modifications in the home e.g. rails, adequate lighting
    - Proper vision
    - Routine check up
    - Modifying medications for blood pressure, blood sugar & the brain by reducing dosage or finding alternatives (with dr. advice)
14. Do you think more attention should be paid to the problem of falling among the elderly?
15. Do you own a phone?
16. What is your opinion on the use of technology such as a phone to prevent falls?
17. Would you use a phone app that monitors vitals to supplement doctor's visit? (Vitals could be used to predict thus prevent falls)
18. Would you be willing to pay for said app?
19. How much max?
20. Would you use wearable technology e.g. smart watch or necklace that monitors vitals to supplement doctor's visit? (Vitals could be used to predict thus prevent falls)
21. Would you prefer the watch or necklace version?
22. Would you be willing to pay for said technology?
23. How much max?
24. Would you use an app or wearable technology that automatically senses when they fall and alerts your family or other caregivers?
25. Would you be willing to pay for said technology?
26. If your caregiver e.g. children paid for the above technology would you use it?
27. Any other comments?