# Age-related lifestyle changes and health in rural environments: A focus on current concerns within Wales.

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#### Abstract

The rapidly ageing population has been identified as a major global challenge; within Wales there is a growing imbalance in the age-profiles of rural communities in particular. The demands of providing appropriate healthcare for a changing population are exacerbated by lifestyle changes associated with ageing, specifically low levels of physical activity, reduced exposure to the sun and compromised ability to synthesise vitamin D. This report focuses on two important health outcomes affected by these changes that are of increasing concern within Wales: diabetes (T2DM) and falls incidence. The report critically reviews the evidence base pertaining to the relationships between physical activity, vitamin D, and both the pathogenesis of T2DM and falls incidence. Current interventions are discussed and a series of recommendations for service delivery within Wales' rural communities are presented. We argue that there is a clear role for targeting these modifiable lifestyle factors in reducing the prevalence and severity of falls and diabetes, two growing areas of social and economic concern within Wales.

KEYWORDS: diabetes; falls; vitamin D; physical activity.

# Wales' ageing rural population:

The rapidly ageing population has been identified as a major global challenge, with individuals over 60 years of age comprising 18% of the worldwide population in 2012, and the total number of older people expected to surpass 1 billion within ten years (United Nations Population Fund [UNPF], 2012). Within the United Kingdom, Wales has the highest population percentage over retirement age, with an expected rise to over 25% by 2033 (Office of National Statistics, 2008). As such, adequate service provision for the ageing population in Wales has been recognised as one of the key issues facing the 4<sup>th</sup> Assembly (National Assembly Research Service, 2011). In terms of governmental responsibilities, the UNPF has argued that good health must lie at the core of society's response to population ageing, and for policies to include the promotion of healthy lifestyles.

Of relevance to Wales, the aforementioned population changes are exacerbated in rural areas, with a growing imbalance in the age-profiles of rural communities (Hartwell, Kitchen, Milbourne, & Morgan, 2007). This is typically attributed to out-migration of younger groups for employment or housing reasons (Stockdale, 2004), and in-migration of older individuals (e.g., those retiring). As a predominantly rural country, Wales contains a number of designated rural local authorities (e.g., Carmarthenshire, Ceredigion, Conwy, Denbighshire, Gwynedd, Monmouthshire, Pembrokeshire, Powys and Ynys Mon/Anglesey), as well as rural areas within other authorities (e.g., Flintshire and the Vale of Glamorgan) [Wales Rural Observatory]. It is also noteworthy that overall populations of these rural counties is increasing, particularly in mid-Wales (Hartwell et al., 2007), which creates a series of challenges in terms of improving healthcare provision in these areas.

# Age-related lifestyle changes:

The demands of providing appropriate healthcare for an ageing population are further exacerbated by lifestyle changes associated with ageing. Although the benefits of physical activity and exercise are well-documented, for instance, improved quality of life, decreased likelihood of depression and cardiovascular disease, and improved muscle strength and joint flexibility (e.g., Aoyagi, Park, Park, & Shephard, 2010; Barreto, 2009; Barbour, Edenfield, & Blumenthal, 2007), physical activity levels decrease progressively with age. Many older adults perceive age and/or poor health as barriers preventing them from being physically active (Whaley & Ebbeck, 2002; Wurm, Tomasik, & Tesch-Römer, 2010). This problem is exacerbated in older people who have fallen, as falling often has a number of psychological consequences (fear of falling, loss of confidence, and activity avoidance) that present further barriers to being physically active (see Jørstad, Hauer, Becker, & Lamb, 2005). Even for those who have not previously fallen, age-related increases in fear of falling have been shown to negatively affect levels of recreational physical activity (Bruce, Devine, & Prince, 2002).

As physical activity decreases with age there is a concomitant decrease in time spent outdoors (Janssen et al., 2002) influencing the amount of time the elderly population are exposing their skin to direct sunlight. Since the primary source of vitamin D is via synthesis in the skin this leaves the elderly at an increased risk of vitamin D deficiency. While this is not an issue exclusively affecting the elderly, vitamin D deficiency is now considered to be an epidemic with 50% of the global population at risk (Prentice, 2008). The elderly are at additional risk due to decreased dietary intake and reduced ability to synthesise vitamin D in the skin (Janssen et al., 2002). Taken together, the low levels of physical activity, reduced exposure to the sun and compromised ability to synthesise vitamin D have a number of consequences for the health of an ageing population; in this report we focus on two major health issues strongly linked with vitamin D, namely diabetes and falls incidence. These are current major health issues within Wales.

## Consequences of lifestyle changes for health: Falls

It has long been recognised that falls in older people are a major public health concern given associated mortality and high treatment costs to the NHS (e.g., Massud & Morris, 2001). It is estimated that one in three adults aged 65 and older will fall each year (Hausdorff, Rios, & Edelber, 2001), with falls the leading cause of injury resulting in death, nonfatal injuries, and hospital trauma admissions for over 65s (Hornbroook et al., 1994). In addition to primary treatment costs, the long-term care costs of falls can also be high, with falls being a predisposing factor in 40% of incidents leading to long-term institutional care in older adults (Kennedy & Coppard, 1987). Of the modifiable risk factors associated with falls, meta-analyses have supported the importance of a number of factors that are affected by physical inactivity, including muscular weakness, balance deficits and mobility or gait limitations (e.g., Sturnieks et al., 2004). Further, epidemiological evidence highlights the contribution of being physically active to reducing the risk of not only falls prevalence but also severity of consequences, with prospective and case control studies identifying a 20-40% reduced risk of hip fracture in those that are physically active compared to sedentary individuals (Gregg, Pereira, & Caspersen, 2000).

Concordant with an increased risk of falls resulting from physical inactivity, vitamin D deficiency is also a predictor of increased risk of falling (O'Donnell et al, 2008). Projected mechanisms of this effect include a reported association between vitamin D deficiency and poor neuromuscular function, as well as emerging evidence suggesting that vitamin D status effects postural and dynamic balance (Boersma, 2012). Altered gait, difficulty rising from a chair and muscle pain are some of the classic symptoms of vitamin D deficiency (Pfeifer et al. 2002), and the results from several epidemiological studies have concluded that individuals with greater muscle function (strength and mass) had diets and lifestyle factors conducive to higher vitamin D status (assessed by 25(OH)D) (Pfeifer et al. 2002; Visser 2003; Bischoff-Ferrari et al. 2004). In terms of the relative importance of vitamin D, although

levels were not directly measured, Faulkner et al. (2009) identified that going outdoors infrequently had an independent effect on fall risk over and above physical risk factors. In addition to vitamin D deficiency increasing the risk of falling (O'Donnell et al, 2008), those who have insufficient vitamin D levels are also at an increased risk of fracture when they do fall (Nakamura et al, 2010; Schoor et al, 2008) as vitamin D is a key regulator of bone metabolism, and deficiency accelerates bone loss (Lips, 2001).

### Consequences of lifestyle changes for health: Diabetes

The worldwide prevalence of diabetes is on the increase; estimated to be 130 million in 1995 this figure is predicted to rise to 300 million by 2025 (Pierce, 1999). Type 2 diabetes mellitus (2DM) accounts for around 90-95% of all cases (Albright et al., 2000), and as such this metabolic disorder is positioned to be one of the largest epidemics in human history (Zimmet et al., 2003). In the UK an individual is diagnosed with type 2DM every three minutes (Diabetes UK, 2008). Whilst type 2DM does have genetic determinants, it is estimated that nine out of ten cases are attributable to lifestyle choices such as participation in physical activity and diet (Hu et al., 2001).

Vitamin D deficiency and type 2DM share many risk factors; obesity, elderly population, low PA levels (less time spent outdoors), and poor diet (Liviu, 2009). There is now mounting evidence of a relationship between vitamin D and the pathogenesis of type 2DM (Alfonso, Liao, Busta, & L, 2009). A number of cross sectional studies have shown inverse associations between serum 25(OH)D concentrations and the presence of type 2DM or measurements of glycemia in a variety of different populations (Baynes et al., 1997; Chiu et al. 2004; Scragg et al. 2004; Ford, Ajani, McGuire, & S. Liu, 2005; (Need, O'Loughlin, Horowitz, & Nordin, 2005)(Forouhi, Luan, Cooper, Boucher, & Wareham, 2008); (Hyppönen & Power, 2006). Data from the National Health and Nutrition Examination Survey (NHANES) reported that

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after multivariate adjustment serum 25(OH)D concentrations were inversely associated with the prevalence of type 2DM in a dose dependant manor in Mexican-Americans and non-Hispanic whites (Ford et al., 2005); Scragg et al. 2004). In a 22 year prospective study it was reported that men had higher 25(OH)D concentrations than women, the men in the highest quartile of baseline vitamin D concentration had a 72% decreased risk of developing type 2DM (Knekt et al. 2008).

In terms of physical activity, epidemiological research indicates that physically active individuals are 30-50% less likely to develop diabetes than sedentary populations (Bassuk and Manson, 2005). There is empirical support for as little as 30 min·day<sup>-1</sup> of moderate intensity activity having a protective effect against diabetes (Hu et al., 2003; Kriska, 2000). For example, in a 6.9 year follow up in the Women's Health Study, walking briskly for a minimum of 2-3 h·wk<sup>-1</sup> was associated with a 34% decrease of the likelihood of developing diabetes when compared to non-walking women (Weinstein et al., 2004). In the Iowa Women's Health Study (Folsom et al., 2000), which followed over 34,000 women aged between 55–69 y for 12 years, those partaking in moderate-intensity exercise at least once per week, two to four times per week, and more than four times per week were 10, 14, and 27% less likely, respectively, to develop diabetes than women partaking in such exercise less than once per week. Additionally, type 2DM is associated with an increased risk of cardiovascular disease and overall mortality, both of which are significantly decreased by regular PA (Wei et al., 2000).

#### Reducing falls risk: current interventions.

A number of existing interventions have been designed to reduce the incidence of falls in the community in pre-fallers, those at risk of falls, and those who have experienced a fall. Interventions targeting vitamin D levels have generally shown positive effects on reducing

falls and improving risk factors associated with falls. For example, Pfeifer et al. (2002) found that supplementation for 2 months with vitamin D (800 International Units (IU)·day<sup>-1</sup>) plus calcium (1200 mg·day<sup>-1</sup>) when compared with calcium (1200 mg·day<sup>-1</sup>) alone observed a significant decrease 9% (p = 0.0435) in body sway in the combined supplementation group. In the vitamin D group mean 25(OH)D concentrations increased from  $25.7\pm13.6$  to  $40.5\pm27.0$ nmol·L<sup>-1</sup> (Pfeifer et al., 2000). Another randomised control trial showed a 49% reduction in the risk of falling in elderly women when supplemented for 3 months with vitamin D (800 IU·day<sup>-1</sup>) and calcium (1200 mg·day<sup>-1</sup>) compared to calcium (1200 mg·day<sup>-1</sup>) alone (Bischoff et al., 2003).

In addition, it is widely accepted that at-risk elderly people, including falls patients, can benefit from physical activity and exercise interventions, achieving improvements in physiological factors, functional status and psychological health (e.g., perceived health status; Barreto, 2009). The positive impact of exercise programmes, including moderate intensity exercise, strength training, postural stability training, and general physical activity interventions, on reducing falls risk and improving health in older populations has been widely evidenced (e.g., Faber, Bosscher, Chin A Paw, & van Wieringen, 2006; Heyn, Abreu, & Ottenbacher, 2004). To present an idea of the magnitude of the effects, Barnett et al. (2003) reported a 40% reduction in the rate of falls in the physical activity intervention group when compared to control group (IRR=0.60, 95% CI 0.36–0.99).

Recent work has confirmed that such programmes can be successfully delivered within rural communities within Wales. For example, Hudson, Oliver, Thomas, and Higgs (2012) examined changes in a cohort of elderly adults, identified as either fallers or at risk of falling, on a 32-week community-based postural stability training course. The programme was a joint initiative between the local health board, the county council, and the National Exercise Referral Scheme, and involved community-based sessions supplemented by home exercises.

Data strongly supported the programme's impact on patients' functional ability, with significant improvements in sit-to-stand ( $M_{wk1} = 26.36$ ,  $M_{wk32} = 16.22$ , p < .001,  $\Delta$ % 38.46) and timed up and go ( $M_{wk1} = 15.89$ ,  $M_{wk32} = 12.02$ , p < .005,  $\Delta$ % 24.35) tests. In addition, confidence in maintaining balance significantly increased ( $M_{wk1} = 18.46$ ,  $M_{wk32} = 15.83$ , p < .005,  $\Delta$ % 14.24), and the change in efficacy for avoiding falls approached significance ( $M_{wk1} = 13.33$ ,  $M_{wk32} = 10.84$ , p = .068,  $\Delta$ % 18.68). Other functional and psychological variables of interest (e.g., 180 degree turn test, functional reach, and quality of life) all demonstrated nonsignificant improvements. In terms of this cohort, interview data highlighted durable positive changes in attitudes towards exercise and physical activities more generally, improved esteem and confidence, and an enhanced sense of perceived social provision and support/involvement due to the class. In sum, the 32-week programme evidenced improvements in participants' functional ability and psychological predictors of health and future falls.

#### Combating Diabetes: current interventions.

The National Service Framework for diabetes is due to be delivered by 2013. This document comments on access to structured education for those with the diagnosis of Type 2 diabetes, as well as the importance of lifestyle modifications. Despite this, resourcing such packages continues to be a challenge for the Health Service and only a minority of individuals with the condition have access to the schemes. This is despite the fact that interventions are underpinned by a growing evidence base indicating positive effects of physical activity on diabetes severity and symptomology. For example, Pan et al., (1997) observed a significant decrease in type 2DM over a six year walking intervention trial, and several other studies have observed that mild-moderate intensity exercise lowers blood glucose in type 2 diabetics (Albright et al., 2000). Larsen et al. (1997) observed the same plasma glucose – insulin

lowering effect during high intensity intermittent exercise, and moderate intensity exercise performed postprandial (following a meal) when energy expenditure was equal. It is believed that a majority of the improvements in glucose tolerance and insulin resistance in response to exercise are the result of the acute effect of lowering of blood glucose levels and decreasing insulin resistance from each specific bout of exercise (Kelly et al., 1999), and as such continued lifelong participation is essential.

In addition to increasing physical activity levels and broader dietary modification (e.g., controlled intake of carbohydrates) research supports the role of vitamin D supplementation in the prevention and management of diabetes. A recent study (Nikooyeh et al., 2011) exploring the effect of a yogurt drink fortified with vitamin D and/or calcium reported that the vitamin D fortified drink improved glycemic status in subjects with type 2 diabetes. An inverse correlation was observed between changes in serum 25(OH)D<sub>3</sub> and fasting serum glucose (r = -0.208, p = 0.049), and insulin resistance (calculated using Homeostasis Model Assessment method) (r = -0.219, p = 0.005). Significant improvements have also been seen in insulin sensitivity and fasting insulin with supplementation (4000 IU daily) compared with placebo (von Hurst et al., 2008). Recent, unpublished, data exploring vitamin D levels in a West Wales population observed significant seasonal variations in vitamin D in individuals with abnormal glucose control. Whilst it appears that individuals living in Wales obtain adequate vitamin D following sun exposure during the summer, this group had sub-optimal  $(25(OH)D_3 < 70 \text{ nmol} \cdot \text{L}^{-1})$  vitamin D concentrations during the winter. Significant relationships were also observed between vitamin D concentrations and glucose values, highlighting the importance of maintaining optimal vitamin levels in relation to diabetes risk. Findings such as these have reinforced calls for supplementation of vitamin D to be considered as a viable intervention to assist with diabetes management.

#### Considerations and recommendations for future service delivery within Wales:

Despite the evident utility of both physical activity and vitamin D interventions in terms of combating falls prevalence and diabetes, there are a number of pertinent concerns with their use within Wales' rural communities. In terms of physical activity, changes in population demographics reported earlier have led to some reductions in the provision of leisure services and sporting groups in some areas (Hartwell, Kitchen, Milbourne, & Morgan, 2007). This may make access to both formal programmes and informal leisure activities harder for elderly individuals, a problem exacerbated by transport difficulties. Further, cost-effective programmes may require more centralised delivery, with the potential to negatively affect uptake and adherence particularly for the most inactive individuals. The Hudson et al. (2012) study highlighted a possible benefit of integrating healthcare programmes with leisure services, with the cohort demonstrating high attendance and uptake of follow-on activities. Alternatively, home-based delivery of programmes or care, including monitoring and support, may benefit from utilising available telecare and telehealth technology; currently its efficacy within activity-promotion is unknown. Ensuring adequate access to services, whether health, leisure, or broader support (e.g., charity groups or networks), is a major consideration for future planning in rural areas.

Given existing and emerging evidence highlighting the importance of vitamin D, there is a robust argument to be made for the targeted promotion of outdoor physical activities. Although rural environments present barriers to physical activity (see rationale above), surveyed rural population groups have indicated a preference for exercising outdoors and, crucially, for low to moderate intensity activities such as walking (e.g., Rogers, Markwell, Verhulst, McAuley, & Courneya, 2009). As such, we propose that the rural environment could be promoted as a facilitator not an inhibitor. Existing falls prevention programmes may consider moving beyond indoor provision, with a proposed pathway from supervised activity,

through use of indoor leisure services, to enhanced outdoor activity. Other ways to maximise engagement with the rural environment could include partnerships with relevant organisations (e.g., The Forestry Commission). Lastly, during the winter months supplementation may ameliorate the observed fall in vitamin D levels resulting in beneficial affects on a range of health indices, although this proposition has yet to be tested experimentally.

In sum, we argue that Wales' ageing rural population display low levels of physical activity, limited exposure to the sun and a compromised ability to synthesise vitamin D, with a number of detrimental consequences for health. Crucially, the research reviewed indicates a clear role for these modifiable lifestyle factors in the prevention and management of falls and diabetes, two growing areas of social and economic concern within Wales. It is notable, however, that interventions (dietary or activity based) are still primarily responsive (e.g., following a fall or diagnosis). It is recommended that evidence-based interventions are expanded to maximise participation in preventative programmes as opposed to responsive or unscheduled care.

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