Irish Journal of Medical Science (1971 -)
https://doi.org/10.1007/s11845-021-02579-2

ORIGINAL ARTICLE

The impact of a 6-week community-based physical activity and health education intervention—a pilot study among Irish farmers

Ruth Kavanagh[1,2] · Diane Cooper[2] · John Bolton[2] · Laura Keaver[1]

Received: 11 January 2021 / Accepted: 26 February 2021

Abstract

Background There is a higher prevalence of lifestyle-related diseases among Irish farmers than the general adult population. Lifestyle interventions that increase physical activity and improve dietary patterns have been associated with reduced chronic disease risk and improved quality of life among high-risk populations. The impact of lifestyle interventions among Irish farmers is unknown.

Aim To assess the effectiveness of a community-based intervention on farmer health, cardiovascular fitness, lower limb strength endurance, and dietary intake.

Methods A 6-week physical activity and lifestyle education intervention involving two 60-min circuit-based exercise training sessions and one 60-min health education workshop per week was implemented. Pre- and post-measurements included total body weight, body fat percentage, lean muscle mass, resting blood pressure, fasting blood glucose, cholesterol, triglycerides, cardiovascular fitness, lower limb strength, perceived physical and mental health, and dietary intake.

Results Thirty farmers completed the intervention giving an adherence rate of 75%. At baseline, mean BMI (32.7 ± 4.1 kg/m^2), body fat percent (31.7 ± 6.7), waist circumference (110.2 ± 10.4 cm), systolic (128.7 ± 7.8 mmHg) and diastolic (86.2 ± 6.8 mmHg) blood pressure were higher than recommended levels. Significant improvements ($p < 0.05$) were found for total body weight, BMI, waist and hip circumferences, cardiovascular fitness, lower limb strength endurance, systolic blood pressure, total energy, total fat, total unsaturated fat, monounsaturated fat, saturated fat, trans fat, total carbohydrate, sodium, cholesterol and percentage energy intakes of total fat, saturated fat, protein, and physical and mental health scores.

Conclusions Irish farmers remain at high risk of developing chronic diseases but respond positively to lifestyle intervention.

Keywords Community · Farmer · Health · Intervention

Introduction

Noncommunicable diseases (NCDs) are a major contributor to global and national deaths in Ireland [1, 2]. An increasing body of literature indicates that Irish farmers are disproportionately affected by NCDs in comparison to the general population [3]. Lifestyle and occupational related health concerns such as obesity, dyslipidaemia, hyperglycaemia, hypertension, psychological stress and musculoskeletal disorders are established in this cohort which increases the risk of developing and worsening NCDs [3, 4]. The hazardous unpredictable nature associated with the farming profession due to external factors such as the weather, increasing taxes, rising farm costs and financial instability from fluctuating markets are contributors to increased physical and mental stress [5, 6]. These stressors directly and indirectly increase the risk of farm accidents [7], injuries [3], musculoskeletal disorders [8–10], depression and anxiety among farming populations [11, 12]. Irish farmers report that they are moderately active (67.2%), do not smoke (90.7%) and have lower alcohol intakes than the general Irish population [13]. However, diet appears to be different as farmers report not meeting the recommended 5–7 portions of fruit and vegetable daily (79.3%), and that they consume sugary and/or salty snacks daily (72.1%) [13].

Irish farmers are mostly comprised of older male adults who live in rural areas and have lower education levels [14, 15]. It is well established that population groups who

✉ Laura Keaver
Keaver.Laura@itsligo.ie

1 Department of Health and Nutritional Science, Institute of Technology Sligo, Co. Sligo, Ash Lane, Sligo F91 YW50, Ireland

2 True Fitness, Portarlington, Co. Laois, Ireland

conform to traditional constructs of masculinity are more likely to engage in health risk behaviours and are less likely to seek medical advice [16, 17]. There is a need to design and implement evidence-based lifestyle interventions specific to the farming population in Ireland primarily to improve health biomarkers and quality of life for farmers. This could have wider benefits for families and communities and more broadly for the sustainability, productivity, and profitability of farming in Ireland. The literature suggests that lifestyle interventions which aim to increase participation in physical activity and improve dietary intake and health through education among populations at high risk of developing NCDs lead to improved physiological and psychological outcomes [18-20]. Lifestyle interventions delivered in a community setting that are not time intensive may be appropriate for farmers as this cohort work unpredictable hours and have limited time for recreational activities particularly during specific seasons and for part-time farmers who may have other work commitments [21]. Additionally, health interventions designed specifically for farmers can reduce stigma associated with health interventions, promote social interaction and sense of belonging among those with mutual interests which is imperative for those at risk of social isolation [22, 23]. The purpose of the current study is to determine the impact of 6-week community-based physical activity and lifestyle education intervention among a group of Irish farmers as there is currently no Irish-specific information in this area.

Methodology

Inclusion criteria

This pre-test–post-test intervention study recruited adult farmers aged over 18 years living in the East and South of Ireland between September 2019 and October 2019. Media articles were posted to farming news Web sites, and a recruitment poster was shared to Facebook pages that target farming communities in counties Laois, Offaly and Kildare as they were within commutable distance of the study location. Participants diagnosed as high risk from the physical activity readiness questionnaire (PAR-Q) [24] due to existing injuries or medical conditions were eligible to participate once the researcher was provided with written approval from their general practitioner prior to the intervention.

Exclusion criteria

The following exclusion criteria were applied, but no participants were excluded. Participants who did not provide informed written consent, pregnant women and participants who did not provide written approval from their GP having been classified as high risk from the PAR-Q were excluded from this study.

Six-week intervention

The intervention was designed and delivered by a multidisciplinary team (clinical exercise physiologist, qualified exercise strength and conditioning instructor, dietitian and nutritionist) and is illustrated Fig. 1. Participants met twice over a 3-day period each week for a 2-h session (1-h health education workshop followed by 1 h of circuit-based exercise training) and again for a 1-h circuit-based exercise training session. The health education workshop content focused primarily on the importance of healthy eating and regular multimodal exercise, understanding food labels and metabolic and cardiovascular health (Supplementary Table 1). These components were chosen based on their effectiveness in previous interventions [25-29]. A workshop on injury prevention and rehabilitation was delivered as a high prevalence of back injuries and musculoskeletal health issues are reported among Irish farmers [30, 31], and these are largely preventable and treated through regular strengthening and flexibility exercise [32]. Goal setting was also included as it is identified as an effective technique in healthy eating and physical activity interventions [33, 34]. The multimodal exercise sessions consisted of a 15-min warm-up phase involving 10 min of low-to-moderate intensity aerobic exercises followed by 5 min of dynamic stretching. The main phase involved 35 minutes of combined aerobic exercises, body weight resistance exercises and flexibility exercises. Ten aerobic exercises were performed for 45 s followed by 15 s of active rest. The same 10 aerobic exercises were then repeated. Ten minutes of core and body weight resistance exercises were performed for 45 s followed by 15-s rest. Participants then completed 5 min of flexibility exercises. Each exercise was performed for 10 repetitions and held for 2 s. All sessions concluded with 5 min of low-intensity aerobic exercises and 5 min of static stretching.

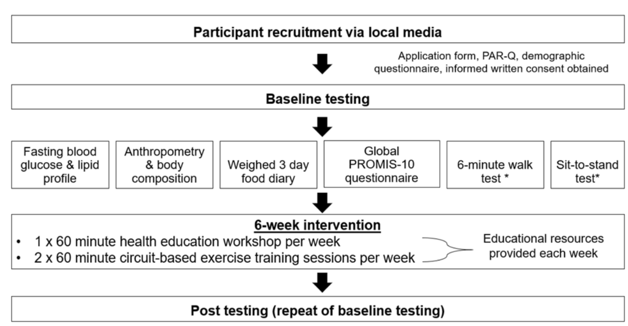

Fig. 1 Illustration of study design for pilot 6-week intervention

*These tests were completed in a group setting, and participants did not need to fast before these tests were completed.

Behaviour Change Techniques

The intervention employed multiple behaviour change techniques derived from a published taxonomy [35]. An outline of the behaviour change techniques used in this intervention can be seen in Supplementary Table 2.

Data collection

Demographic data

A demographic questionnaire was created to collect data regarding participant sex, age group, farm enterprise, occupation status, living arrangements, meal preparation as well as one question on participants perception of importance on the role of physical activity and nutrition on health.

Perceived physical and mental health

Physical and mental health scores were obtained using the Patient-Reported Outcomes Measurement Information System-10 (PROMIS-10) questionnaire [36]. As specific components of the PROMIS Global-10 questionnaire correspond with physical health outcomes and others correlate with mental health outcomes, questionnaires were scored to provide a physical health score (PHS) and a mental health score (MHS) for each participant pre- and post-intervention to assess general health related quality of life. A PHS was calculated as per manufacturers guidelines by adding responses to global03 (physical health), global06 (physical function), global07 (pain) and global08 (fatigue) to provide a raw score. A MHS was calculated as per manufacturers guidelines by adding responses to global02 (quality of life), global04 (mental health), global05 (satisfaction with discretionary social activities) and global10 (emotional problems) to provide a raw score. The total respective raw scores were used to determine t-scores using manufacturers scoring manual [36].

Physical, cardiovascular and metabolic health

Data was collected pre and post the 6-week intervention, with post-testing occurring within 13 days of the last training session. Participants were asked to fast and to avoid moderate or high intensity exercise for 12 h prior to their private pre-testing appointment which occurred in the morning. Bicep, chest, waist and hip measurements were recorded following established guidelines [37]. Height was recorded using a stadiometer, ensuring that the participants feet, gluteus maximus and occiput were in contact with the backboard while the participant's head was placed in the Frankfurt Plane and their arms hung loosely at their sides. Participants' feet were flat and placed together. Total body weight, lean muscle mass and body fat percentage was analysed using a calibrated Tanita Innerscan Segmental Body Composition Monitor (BC545). Participants were asked to remove any contents from their pockets, belts, shoes and socks before stepping on the scales. Body mass index (BMI) was calculated by dividing total body weight in kilograms by height in metres squared [38]. The World Health Organisation (WHO) classification of BMI for normal weight, overweight and obese categories was used [38]. Resting blood pressure was recorded following guidelines outlined previously [39], whereby participants were asked to remove long-sleeved clothing so that the cuff could be placed around the skin on the upper arm. Participants sat in a seated position with both feet touching the floor for 3–5 min before blood pressure was assessed and were asked not to speak until the measurement had been recorded [39]. A fasting 40 μl fasting blood capillary sample was obtained using a lancing device (Accu-Chek Safe-T-Pro Plus) and capillary pipette to determine total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) levels using the Cardio-Chek professional analyser point-of-care device. This device was checked prior to each use using a test strip and was subject to a quality control check before pre-testing began using specific controls provided by the manufacturer which is recommended every 6 months. Fasting blood glucose (FBG) levels were determined using the One Touch Verio glucometer.

Cardiovascular fitness and lower limb strength endurance

During the first and last group training session of the intervention, participants completed a 6-min walk test [40] and a 60-s sit-to-stand test [41]. For the 6-min walk test, two cones were placed 20 m apart on a flat hard surface outdoors. One lap was equivalent to 40 m. Participants were instructed by a person trained in the method to walk, jog or run the maximum distance between the cones for 6 min. Verbal encouragement was used after each minute of the test elapsed. Afterwards, participants were encouraged to perform as many full sit-to-stands as possible from a chair which was placed against a wall indoors for stability. The total number of sit-to-stand repetitions was recorded.

Dietary intake

Dietary intake was assessed using a comprehensive weighed paper-based 3-day food diary (3DFD) on two weekdays and one weekend day. Participants were given an informational talk individually during the baseline testing appointment on how to accurately record a 3DFD and were provided with an opportunity to ask questions. Participants were encouraged to maintain usual dietary habits and were encouraged to weigh all food and drink prior and after consumption to quantify actual food and drink consumed. The use of household measures was also discussed for situations where weighing food was not possible. Participants could equate to a household measure, e.g. two tablespoons or they could quantify the number of food/drink items for example 2 large eggs. For each daily entry participants were asked if dietary intake represented habitual intake and a comment section was used to record reasoning to support if dietary intake did not represent habitual intake. The quotes from the comment section can be seen in the 'Results' section. A total of four text messages as part of pre- and post-testing was sent to all participants reminding them to complete and return their 3DFD to increase adherence.

Dietary analysis

Dietary intake was analysed using Nutritics dietary analysis software package research edition v5.096. A new product was created using the nutritional information provided from the Tesco Ireland or SuperValu online websites for products recorded that were not registered on Nutritics. The Food Portion Sizes third edition book by the Food Standards Agency was used to provide average portion sizes for unstated weights in the 3DFD [42]. The Goldberg cutoff method was used to determine the mean group bias of reported energy intake pre- and post-intervention [43]. Under-reporters and over-reporters were identified based on an estimated physical activity level (PAL) of 1.6, and this value was compared to the ratio of mean energy intake (EI) to mean basal metabolic rate (BMR). A PAL value of 1.6 was used as energy expenditure was unknown and choosing a higher value may exaggerate the extent of under-reporting [43, 44]. BMR was estimated using the Schofield equations for males and females based on gender, age, weight and height [45].

Adherence to dietary guidelines

Adherence to a total of 16 nutrient recommendations created by the World Health Organisation [46], the European Society of Cardiology [47], the Scientific Advisory Committee on Nutrition [48] and the World Cancer Research Fund [49] was assessed pre and post the 6-week intervention (Supplementary Table 3).

Metabolic syndrome classification

Participants were classified as having the metabolic syndrome following the International Diabetes Federation criteria whereby an individual is classified as being abdominally obese (≥ 94 cm in males, ≥ 80 cm in females) in addition to any two of the following factors, (1) raised fasting plasma glucose (≥ 5.6 mmol/L), or previously diagnosed type 2 diabetes, (2) raised triglycerides (≥ 1.7 mmol/L), or specific treatment for this lipid abnormality, (3) reduced HDL-C (< 1.03 mmol/L in males, < 1.29 mmol/L in females), or specific treatment for this lipid abnormality, (4) raised blood pressure (systolic blood pressure ≥ 130 or diastolic blood pressure ≥ 85 mmHg), or treatment of previously diagnosed hypertension [50].

Statistical analysis

Data was analysed using SPSS version 24 and significance was established at $p < 0.05$. Normality of data was established using the Shapiro–Wilks test. Paired samples *t*-tests were used to assess the impact of the 6-week intervention by comparing mean differences between pre- and post-test results for parametric data sets. The Wilcoxon signed rank test was used to assess median differences between pre and post nonparametric data sets [51].

Ethical approval

Ethical approval was granted from the Research Ethics Committee at the Institute of Technology Sligo (reference number 2020038), and informed written consent was obtained from all participants before commencing any testing.

Results

Participation and adherence rates

Fifty-four participants contacted the researcher expressing interest in this research study. Forty of these were eligible and attended baseline testing. Two participants withdrew from the study before the 6-week intervention started, therefore 38 individuals started the intervention. Over the 6-week intervention period, 5 participants withdrew from the study due to travel and work commitments ($n = 3$) or were lost to follow-up ($n = 2$). Three participants did not complete all necessary post-tests. Therefore, 30 participants (90% male, 10% female) completed all post-tests excluding dietary analysis to give an adherence rate of 75%. Twenty-five participants ($n = 23$ male, $n = 2$ female) returned completed 3DFD to give an adherence rate of 65.8%. Almost one third of the sample attended all 12 sessions (28.8%, $n = 11$). Attendance at sessions ranged from 1 to 12. The mean number of sessions attended was 11 ± 1.

Participant characteristics

The majority of participants were male ($n = 27$, 90%), non-smokers ($n = 25$, 83.3%), part-time farmers ($n = 24$, 80%) aged between 36 and 59 years ($n = 18$, 60%). Drystock ($n = 10$, 33.3%) and dairy ($n = 9$, 30%) were the most popular farm enterprises. Most farmers lived with their partner/family/relatives ($n = 27$, 90%) and perceived regular physical activity ($n = 29$, 96.7%) and nutrition ($n = 29$, 96.6%) to be important or very important for health. The majority ($n = 23$, 76.7%) had never taken part in any weight loss or healthy living programme (Table 1).

Pre- and post-test risk factors

The physical, cardiovascular and metabolic health characteristics pre- and post-intervention can be seen in Table 2. Pre- and post-intervention, all participants were classified as overweight or obese and most could be classified as having the metabolic syndrome following classification from the International Diabetes Federation (47) (56.7% pre vs 53.3% post) (Table 3). At baseline, mean body fat percent ($M = 31.7$, $SD = 6.7$), waist circumference ($M = 110.2$, $SD = 10.4$ cm), systolic ($M = 128.7$, $SD = 7.8$ mmHg) and diastolic ($M = 86.2$, $SD = 6.8$ mmHg) blood pressure were higher than recommended levels [40, 50, 52]. Post-intervention, there were significant changes ($p < 0.05$) in all variables except for lean muscle mass, waist-to-hip ratio, diastolic blood pressure, total cholesterol, HDL-C, LDL-C, triglycerides and fasting glucose (Table 2). There were less participants classified as having a high fasting blood glucose level, high cholesterol and low HDL-C levels post-intervention. More participants exceeded the recommended triglyceride level post-intervention (Table 3).

Dietary intake

Participant intake pre- and post-intervention can be seen in Table 4. Overall, diets were high in total fat, saturated fat, sodium, salt and low in fibre and trans-fat. Seventy six percent and 74.67% of participants stated that dietary intake represented habitual intake pre- and post-intervention, respectively ($n = 25$). Reasons as to why intake did not represent habitual intake included: "I was at a wedding so I consumed a lot more alcohol than I normally would" (male, age 28); "My food intake depends on whether my wife is at home to prepare my meals. If she is away then I eat out or else I won't eat dinner at all" (male, age 53); "I had a 3-course meal for my son's birthday, this is not typical every weekend" (male, age 55); "When I work away from home I usually get my lunch from a shop deli so it could be a breakfast roll or a ham & salad roll with crisps etc" (male, age 47); "I was away for the weekend hence the bad diet" (male aged 32); "I may not have a takeaway every weekend" (female, age 29); "I was stressed. I eat more when I am stressed" (male, age 62). Using the Goldberg cutoff method, 72% were classified as under-reporters ($n = 18$), 20% of participants were classified as plausible reporters ($n = 5$) and 8% were classified as over-reporters ($n = 2$) pre intervention. 84% were classified as under-reporters ($n = 21$), 12% were plausible reporters ($n = 3$) and 4% were classified as over-reporters ($n = 1$) post-intervention. There were significant ($p < 0.05$) dietary intake changes for total energy, total fat, saturated fat, trans fat, monounsaturated fat, total unsaturated fat, carbohydrate, sodium, cholesterol in terms of grams or milligrams per day and for the percentage of energy consumed as protein, total fat and saturated fat.

Adherence to dietary guidelines

No participant adhered to all dietary guidelines (Table 5). There was a significant increase in the median total number of dietary guidelines adhered to from pre ($Mdn = 5$, $IQR = 4$) to post ($Mdn = 6$, $IQR = 3$) intervention, $z = -2.17$, $p = 0.03$. All participants adhered to the trans-fat guideline. No participant adhered to the recommendation that free sugars should not exceed 5% of total energy intake (TEI) or to the 30g daily recommendation of unsalted nuts pre- or post-intervention. Adherence to the recommendations that free sugars should be less than 5% of total energy intake, vegetable intake should be ≥ 200 g and 30 g of unsalted nuts daily remained the same post-intervention. Adherence improved for all other dietary guidelines except for the protein recommendation that protein intake should represent 10–15% of total energy intake. All participants who did not adhere to the protein guideline exceeded recommended protein intake.

Discussion and Conclusion

This study found Irish farmers at high risk of developing lifestyle related diseases responded positively to a 6-week physical activity and lifestyle education intervention. Most farmers pre-intervention exceeded healthy BMI and waist circumference guidelines, were classified as having the metabolic syndrome, consumed diets high in total fat, saturated fat, sodium, salt and low in fibre and trans-fat. Overall, post-intervention, there were improvements in most health characteristics except for lean muscle mass, waist-to-hip ratio, diastolic blood pressure, total cholesterol, HDL-C, LDL-C, triglycerides and fasting glucose. Adherence to dietary guidelines also increased.

Pre- and post-intervention, 100% of farmers who took part in this trial were classified as overweight or obese which is greater than the 60% of the general Irish adult population [53]. It is established that abdominal obesity

Table 1 Participant characteristics

	Total sample, *n* (%)
Gender	
Male	27 (90)
Female	3 (10)
Age, mean (SD)	50 (12)
Age range	
18–35	4 (13.3)
36–49	9 (30)
50–59	9 (30)
60–69	8 (26.7)
Farming type	
Full time	6 (20)
Part time	24 (80)
Farm enterprise	
Drystock	10 (33.3)
Dairy	9 (30)
Tillage	3 (10)
Mixed farm enterprise	7 (23.3)
Self-reported health conditions	
Family history of heart disease	9 (30)
High blood pressure	3 (10)
High cholesterol	5 (16.7)
Joint disorders	3 (10)
Bone disorders	1 (3.3)
Muscle injuries	2 (6.7)
Back pain	12 (40)
Asthma	4 (13.3)
Smoking status	
Smoker	5 (16.7)
Non-smoker	25 (83.3)
Living arrangements	
Alone	3 (10)
With partner/family/relatives	27 (90)
Have you ever taken part in any weight loss or healthy living programme? *	
Yes	6 (20)
No	23 (76.7)
Who prepares most of your meals?	
I prepare my own meals	6 (20)
My family member/friend/other prepares most of my meals	12 (40)
I prepare my meals with my family member/friend/other	12 (40)
Perceived importance of regular PA for health	
Very important	20 (66.7)
Important	9 (30)
Somewhat important	1 (3.3)
Undecided	0 (0)
Not important	0 (0)
Really not important	0 (0)
Perceived importance of nutrition for health	
Very important	19 (63.3)
Important	10 (33.3)
Somewhat important	1 (3.3)
Undecided	0 (0)

Table 1 (continued)

	Total sample, *n* (%)
Not important	0 (0)
Really not important	0 (0)

*$n = 29$

classified by WC is a strong predictor of excess visceral adipose tissue and is a more favourable predictor of health risk than BMI [37]. Our study found that 93.3% and 90% of participants were classified as abdominally obese pre- and post-intervention. These results are similar to a previous Irish study which found that 86% of farmers were overweight or obese and that 80% were abdominally obese [4]. Our study found that most farmers exceeded recommended blood pressure levels (70%; $n = 21$ pre vs 60%; $n = 18$ post). However, just 10% of farmers stated that they had

Table 2 Mean (± SD) or median (Mdn), interquartile range (IQR) for physical, cardiovascular and metabolic health characteristics pre and post the 6-week intervention

	Number	Pre	Post	Δ Change	Statistical significance	Recommended
Physical characteristics						
Weight (kg)	30	(97.2 ± 15)	(95.6 ± 14.9)	(−1.6 ± 2.7)	0.03**	N/A
BMI (kg/m^2)	30	(32.7 ± 4.1)	(32.1 ± 4.2)	(−0.5 ± 0.9)	0.02**	18.5–25
Body fat %	28	(31.7 ± 6.7)	(30.8 ± 7.5)	(−0.9 ± 1.9)	0.02**	10–22% (M) 20–32% (F)
Lean muscle mass (kg)	28	(62.7 ± 9)	(62.3 ± 8.1)	(−0.3 ±1.7)	0.3	N/A
Hydration	28	(48.9 ± 4.5)	(50 ± 5.4)	(+1.1 ±2.6)	0.03**	N/A
Bicep (cm) (Mdn, IQR)	30	(35.9, 3.4)	(34.6, 3.9)	(−1.2, 1.6)	0.01**	N/A
Chest (cm)	30	(112.6 ± 8.7)	(110.1 ± 8.4)	(−2.4 ± 2.2)	0.00**	N/A
Waist (cm)	30	(110.2 ± 10.4)	(106.4 ±10.5)	(−3.8 ±3.2)	0.00**	< 94 (M) < 80 (F)
Hips (cm)	30	(104.4 ± 6.9)	(102.7 ± 7)	(−1.7 ± 2.5)	0.001**	N/A
Waist:hip	30	(1.05 ± 0.07)	(1 ± 0.2)	(−0.06 ± 0.2)	1.36	0.9 (M) 0.85 (F)
Fitness and strength characteristics						
Six-minute walk test (m) (Mdn, IQR)	30	(680, 280)	(960, 200)	(+120, 80)	0.00**	N/A
Sit-to-stand (reps)	30	(38 ± 4.9)	(47.6 ±7.4)	(+9.5 ± 6.6)	0.00**	N/A
Cardiovascular characteristics						
Systolic blood pressure (mmHg)	30	(128.7 ± 7.8)	(124.9 ± 9.9)	(−3.8 ± 9.2)	0.03**	≤ 130
Diastolic blood pressure (mmHg)	30	(86.2 ± 6.8)	(84.2 ± 6.2)	(−2 ± 5.6)	0.06	≤ 85
Total cholesterol (mmol/L)	30	(4.8 ± 1)	(4.6 ± 1.1)	(−0.2 ± 1.1)	0.41	< 5
HDL-C (mmol/L) (Mdn, IQR)	30	(1.3, 0.4)	(1.3 ± 0.5)	(0, 0.2)	0.65	> 1
LDL-C (mmol/L)	27*	(2.8 ± 0.9)	(2.7 ± 1)	(−0.1 ± 1)	0.56	< 3
Triglycerides (mmol/L) (Mdn, IQR)	27*	(1.4, 1.3)	(1.2, 1)	(−0.03 ± 0.6)	0.96	< 2
Metabolic characteristics						
Fasting glucose (mmol/L)	30	(5.5 ± 0.4)	(5.4 ± 0.5)	(−0.05 ± 0.5)	0.58	< 5.6
Physical and mental health score						
Physical health t score***	30	(46.3 ± 5.3)	(50.4 ± 5.5)	(+4.16 ± 4.5)	0.00**	N/A
Mental health t score***	30	(47.27 ± 6)	(51.2 ± 6.4)	(+3.9 ± 6.8)	0.03**	N/A

Values expressed as mean ± standard deviation for parametric data sets or Mdn and IQR for non-parametric data sets

M male, *F* female, *N/A* no recommended values

*The CardioChek device did not provide LDL-C and triglyceride results for three participants during post-testing and were therefore excluded from these analyses; **$p < 0.05$ represents a significant change in the variable post-intervention; ***t Scores calculated as per manufacturer's instructions [36]

Table 3 Metabolic syndrome components among the total sample pre and post the 6-week intervention

	Six-week intervention, n (%)	
	Pre, $n = 30$	Post, $n = 30$
Central obesity (≥ 94 cm M, ≥ 80 cm F)	28 (93.3)	27 (90)
Systolic blood pressure ≥ 130 or diastolic blood pressure ≥ 85 (mmHg)	21 (70)	18 (60)
Fasting blood glucose > 5.6 mmol/L	14 (46.7)	12 (40)
HDL-C (< 1.03 mmol/L M, < 1.29 mmol/L F)	8 (26.7)	6 (20)
Triglycerides > 1.7 mmol/L	7 (26.7)	9 (30)
Participants classified with the metabolic syndrome	17 (56.7)	16 (53.3)

high blood pressure in the baseline health questionnaire. This is likely to indicate a lack of individual awareness to blood pressure unless it is measured during a health check. The literature suggests that males are less likely to seek medical advice than females [16, 17]. Recently, it was found that male farmers in Ireland were more likely to attend their general practitioner for treatment of ill health rather than for preventative purposes [13]. This finding is concerning as most NCDs are asymptomatic in the early stages, a time where intervention is key to prevent progression of these diseases [1]. Gender-specific community-based health promotion programmes in Ireland targeting males such as 'Men on the Move' have presented promising results [54, 55] and could be an effective strategy

Table 4 Mean (± SD) or median (Mdn) and interquartile range (IQR) for daily energy, macronutrient, mineral and alcohol intakes pre and post the 6-week intervention

Nutrient	Pre, $n = 25$	Post, $n = 25$	Δ Change (+/−)	Statistical significance
Energy (kcal) (mean ± SD)	(2487.4 ± 683.7)	(2066.5 ± 675.3)	(−420.9 ± 613.6)	0.00*
Energy (kJ) (mean ± SD)	(10434.6 ± 2859.9)	(8680.4 ± 2826.1)	(−1754.3 ± 2560.6)	0.00*
Protein (g) (mean ± SD)	(109.9 ± 34.2)	(101 ± 32.1)	(−9 ± 32.3)	0.18
Total fat (g) (mean ± SD)	(100.4 ± 33.5)	(77.4 ± 34.9)	(−23 ± 34.3)	0.00*
Saturated fat (g) (mean ± SD)	(41.2 ± 15.6)	(29.9 ± 15.6)	(−11.3 ± 15.2)	0.00*
Trans fat (g) (mean ± SD)	(1.3 ± 0.7)	(1 ± 0.7)	(−0.3 ± 0.7)	0.03*
Monounsaturated fat (g) (mean ± SD)	(31 ± 10.4)	(25.1 ± 12.1)	(−5.9 ± 12.6)	0.03*
Polyunsaturated fat (g) (mean ± SD)	(11.8 ± 4.3)	(11.3 ± 5.3)	(−0.5 ± 4.3)	0.60
Total unsaturated fat (g) (mean ± SD)	(42.7 ± 13.8)	(36.4 ± 16.6)	(−6.4 ± 15.6)	0.05*
Carbohydrate (g) (mean ± SD)	(258.9 ± 66.6)	(228 ± 70)	(−30.9 ± 54.9)	0.01*
Total sugar (g) (mean ± SD)	(90.1 ± 40.3)	(80.1 ± 39)	(−9.9 ± 21.7)	0.03
Free sugar (g) (mean ± SD)	(34.4 ± 25.3)	(29.6 ± 30.3)	(−4.7 ± 29)	0.42
Dietary fibre (g) (mean ± SD)	(24.9 ± 8.2)	(24.8 ± 6.4)	(−0.1 ± 7.5)	0.98
Sodium (g) (mean ± SD)	(2.7 ± 0.9)	(2.2 ± 0.9)	(−0.5 ± 1.1)	0.03*
Salt (g) (mean ± SD)	(6.9 ± 2.3)	(6 ± 2.4)	(−0.9 ± 2.8)	0.12
Cholesterol (mg) (mean ± SD)	(411.3 ± 170.8)	(346.4 ± 191.9)	(−64.9 ± 150)	0.04*
Alcohol (g) (Mdn, IQR)	(3.8, 21.1)	(0, 7.1)	(0, 12)	0.06
Protein (% TEI) (mean ± SD)	(17.7 ± 3.3)	(20.1 ± 4.1)	(+ 2.3 ± 4.4)	0.01*
Total fat (%TEI) (mean ± SD)	(35.9 ± 5.2)	(32.7 ± 6.7)	(−3.2 ± 7.4)	0.04*
Saturated fat (%TEI) (mean ± SD)	(14.7 ± 2.7)	(12.4 ± 2.8)	(−2.2 ± 3.4)	0.00*
Trans fat (%TEI) (mean ± SD)	(0.5 ± 0.2)	(0.40 ± 0.2)	(0.05 ± 0.2)	0.21
MUFA (%TEI) (mean ± SD)	(11.2 ± 2.2)	(10.5 ± 2.9)	(−0.7 ± 3.4)	0.32
PUFA (%TEI) (mean ± SD)	(4.3 ± 1.4)	(5 ± 2.1)	(+ 0.7 ± 1.8)	0.06
Carbohydrate (%TEI) (mean ± SD)	(42.5 ± 6.4)	(45 ± 6.4)	(+2.5 ± 7.2)	0.10
Total sugar (%TEI) (mean ± SD)	(14.6 ± 5)	(15.6 ± 4.7)	(+1 ± 5.4)	0.36
Free sugar (%TEI) (mean ± SD)	(5.6 ± 4.5)	(5.1 ± 3.8)	(−0.4 ± 4.7)	0.66

*$p < 0.05$ represents a significant change in the variable post-intervention

Table 5 Adherence to dietary guidelines pre- and post-intervention

Dietary guideline	Adherence to guideline, *n* (%)	
	Pre, *n* = 25	Post, *n* = 25
Total fat 15–30% TEI [43]	2 (8)	9 (36)
Saturated fat < 10% TEI [44]	0 (0)	4 (16)
USF > SF [44]	16 (64)	21 (84)
Trans fat < 1% TEI [44]	25 (100)	25 (100)
Carbohydrate 55–75% TEI [43]	1 (4)	1 (4)
Free sugars < 5% TEI [45]	0 (0)	0 (0)
Free sugars < 10% TEI [43]	23 (92)	25 (100)
Protein 10–15% TEI [43]	8 (32)	4 (16)
Cholesterol < 300 mg [43]	6 (24)	13 (52)
Salt < 5 g [44]	7 (28)	11 (44)
Sodium < 2 g [44]	7 (28)	11 (44)
Dietary fibre 30–45 g [44, 46]	5 (20)	6 (24)
Alcohol < 20 g males, < 10 g females [44]	19 (76)	22 (88)
Fruit ≥ 200 g [44, 46]	5 (20)	12 (48)
Vegetables ≥ 200 g [44, 46]	9 (36)	9 (36)
Unsalted nuts 30 g [44]	0 (0)	0 (0)
Fish 36 g* [44]	9 (36)	10 (40)

*The ESC recommends 2–3 servings of fish to be consumed weekly, with 1 serving of cooked fish equating to 100 g. Therefore, 200–300 g is recommended per week. For the purpose of the 3DFD, the recommended daily amount was calculated as 36g (200 g + 300 g = 500 g/2 = 250 g, 250g/7 = 36 g) [47]

to improve the health of male farmers specifically. This presents an area for future research as does an investigation on how to target female farmers in Ireland who are a minority and have been neglected in Irish farmer health research to date.

Although lifestyle interventions including supervised exercise sessions and nutrition education have been shown to reduce cardiovascular and metabolic risk factors in adults diagnosed with the metabolic syndrome [17, 56-58], there were no statistically significant changes in mean fasting glucose, total cholesterol, HDL-C, LDL-C, triglycerides or diastolic blood pressure post this 6-week intervention. The intervention was short and not intensive; thus, the volume of training over the 6 weeks may not be enough for significant changes in these variables to occur. The previously mentioned studies ranged in duration from 4 weeks to 12 months. However, there was clinical significance with less participants classified as having the metabolic syndrome, a high fasting blood glucose level, high cholesterol and low HDL-C levels. More participants exceeded the recommended triglyceride level post-intervention (26.7% pre vs 30% post). Therefore, pharmacological intervention for individuals with high triglyceride levels in conjunction with lifestyle behaviours may be needed to reduce triglyceride levels.

Cardiovascular fitness is an independent predictor of health [59] while lower limb strength is an indicator of functional capacity associated with independent living [32]. Cardiovascular fitness and lower limb strength endurance improved significantly post-intervention. The distance completed by healthy adults in the 6MWT has been reported to range from 400 to 700 m [60]. Results from our study show that farmers exceeded these norms post-intervention (*Mdn* = 960, *IQR* = 200 m). Improved fitness reduces the physical stress associated with daily farming activities in addition to other well-established physical and mental health benefits [32]. Mean sit-to-stand performance increased by 9.5 ± 6.6 repetitions post-intervention. Although there are no recommended ranges for sit-to-stand repetitions across the literature, an improvement of three repetitions was associated with benefits for community-dwelling older adults [61, 62]. Increased lower leg strength reduces frailty, injury and risk of falls in later years [32]. There is now strong evidence for the positive relationship between increased physical activity and improved psychological health due to the moderating and mediating effects on self-esteem and self-concepts [32]. Our research found significant improvements in perceived physical and mental health as well as improvements in cardiovascular fitness and lower limb strength. While the association was not tested in this study there is the potential that they are related. An additional explanation for improved mental and physical health perceptions may be from the social support farmers received while attending the community-based intervention as social support is identified as a predictor of subjective wellbeing for men living in rural communities [63, 64].

Diets were high in saturated fat (14.7% and 12.4% pre- and post-intervention), which is similar to findings reported from the *National Adult Nutrition Survey 2011* where saturated fat represented 13.3% of total energy intake [65]. Although fibre intake was greater than the general Irish population (19.2 g) [66] pre (24.9 g) and post (24.8 g) intervention, intakes remained below the 30–45 g recommendation [47, 49]. An inadequate intake of fibre is a common trend among the general Irish population [66] and in other European countries [67], despite the well-established benefits on reducing chronic disease risk and role in weight control [68]. Sodium intake reduced significantly post-intervention as did systolic blood pressure. It is recommended to consume less than 5 g of salt per day [47]. In our study, mean intakes of salt exceeded this recommendation pre (6.92 g) and post (6.01 g) intervention. These findings are less than mean dietary salt intakes of 9.3 g per day reported in the Irish adult population [69]. However, our study does not account for discretionary intake which could account for the differences observed. Excessive intakes of salt are a well-established risk factor for increasing systolic blood pressure [70]. Alcohol overconsumption is a main modifiable risk factor for NCDs [1]. At baseline, 68% of the sample consumed alcohol, of this 24% exceeded the alcohol guideline (Supplementary Table 3). Alcohol consumption reduced post-intervention, and although this was non-significant, less participants consumed alcohol (32%) and exceeded gender specific alcohol guidelines (12%). Although different alcohol guidelines were used in another Irish study, it was reported that 46% of Irish male farmers consume alcohol weekly and 25% reported consuming more than 17 standard drinks weekly [71]. Most participants in this study appeared to under report dietary intake which suggests that adherence to most nutrient recommendations, and dietary guidelines are much lower among this population. Additionally, this finding may also suggest that more participants may have met the fruit, vegetables, unsalted nuts and fish recommendations. All dietary assessment methods have inevitable limitations associated. The 3DFD relies on reporter memory and motivation to accurately measure and record all consumed foods and drinks [72]. The knowledge that food and respective quantities must be recorded may alter dietary behaviours particularly among individuals who are classified as being overweight or obese [73].

Although most farmers (76.7%) did not participate in any weight loss or healthy living programme prior to this study, there was good adherence (75%) to this intervention, indicating that lifestyle interventions specific to the farming community are attractive for members of this industry. Similarly, results from The Farming Fit intervention in Australia indicate that there was a 97% and a 92% adherence to this 6-month intervention among the intervention group and the control group, respectively [74]. A systematic review indicated that mean adherence to community-based exercise programmes ranges between 65 and 86% [75]. The social support embodied in community-based interventions is likely to have played an essential role in facilitating programme adherence which is in accordance with the literature that those who participate in their community have better mental health than their more isolated counterparts [76]. This emphasises the importance of creating health promoting environments which stimulate social interaction, particularly for a population group at risk of social isolation.

Limitations

There are limitations that should be addressed. Methodological choices including the use of point-of-care devices to determine fasting glucose and lipid profile, bioelectrical impedance scale to assess lean muscle mass and body fat and 3DFD to assess dietary intake all have limitations associated [77-79] and more robust methods are warranted. The Goldberg cut-off method was used to determine the mean group bias of reported energy intake pre- and post-intervention. However, this method also has limitations associated with it [44]. For example, PAL was estimated to be 1.6 for all participants and thus future research should include measurements of energy expenditure such as detailed physical activity diaries or accelerometers when assessing dietary intakes to provide a more accurate estimation on the presence of bias [80]. The volume of training and length of the intervention may have been too short to allow for cardiovascular and metabolic changes to be detected.

Conclusion

Despite the limitations, this research indicates that farmers responded positively to a farmer-exclusive community-based lifestyle education and physical activity intervention. Qualitative research is currently being undertaken to determine the long-term impact of this lifestyle intervention on farmer health 12 months post-intervention.

Supplementary information The online version contains supplementary material available at https://doi.org/10.1007/s11845-021-02579-2.

Author contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Ruth Kavanagh and Laura Keaver. The first draft of the manuscript was written by Ruth Kavanagh and Laura Keaver, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Ruth Kavanagh received an employment-based postgraduate scholarship from the Irish Research Council in partnership with True Fitness and the Institute of Technology Sligo (Project ID: EBPPG/2019/118). Laura Keaver was the academic supervisor, Dr Diane Cooper was the employment-based mentor. True Fitness had no role in the analysis of results.

Declarations

Ethics approval Ethical approval was granted from the Research Ethics Committee at the Institute of Technology Sligo. Reference number 2020038.

Consent to participate All participants provided informed written consent.

Consent for publication All participants signed informed consent regarding publishing their data.

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