



Anything is everything

**Evaluation of the EXi mobile app in  
the Provision of Physical Activity to a  
Multidisciplinary Weight Management  
Clinic at St Bartholomew's Hospital,  
London**

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# WHITE PAPER

# SUMMARY

**AIM:** The aim of this investigation is to evaluate the effectiveness of a digital exercise prescription tool (EXi) on a smartphone in engaging and providing an exercise programme to patients referred to a tier 4 obesity clinic.

**METHODS:** This investigation took the form of a real world observational clinical study. The clinical team contacted eligible participants by phone (due to the coronavirus pandemic) during their usual consultations and discussed exercise and the EXi programme. A referral was made to a physiotherapist who contacted patients with a letter explaining the programme and scheduled in a 10-minute call to discuss. The participants downloaded EXi and entered their demographic, health and fitness data which was analysed by the EXi programme. EXi produced a digital personalised physical exercise plan lasting 12 weeks. Once on the programme, the physiotherapist would use the EXi data portal to assess each patient's progress and follow up with an SMS and occasionally a phone call every 2-4 weeks.

After 12 weeks, the user was referred back to the clinical team at Barts hospital with an update showing the patient's exercise level and health metrics. The patient could then continue to use EXi indefinitely, but without follow-up from the clinical team.

**PATIENTS:** n = 71, 20 male, 51 female, average age 43 years. Range of long-term conditions or co-morbidities.

**RESULTS:** Members of the Tier 4 obesity team initially discussed the benefits of exercise with their patients and introduced the EXi solution. 71 patients downloaded the EXi app and were provided with an automated, yet individualised activity programme. Of these people, 92.9% stayed engaged with the activity programme for 4 weeks, 69.0% stayed engaged for 6 weeks, 64.7% stayed engaged for 8 weeks and 56.3% stayed engaged for 12 weeks. The participants were able to increase their average step count at all time points when compared to baseline measures. Participants who recorded their health data demonstrated a weight reduction of 2.4kg and a waist circumference reduction of 4.4cm.

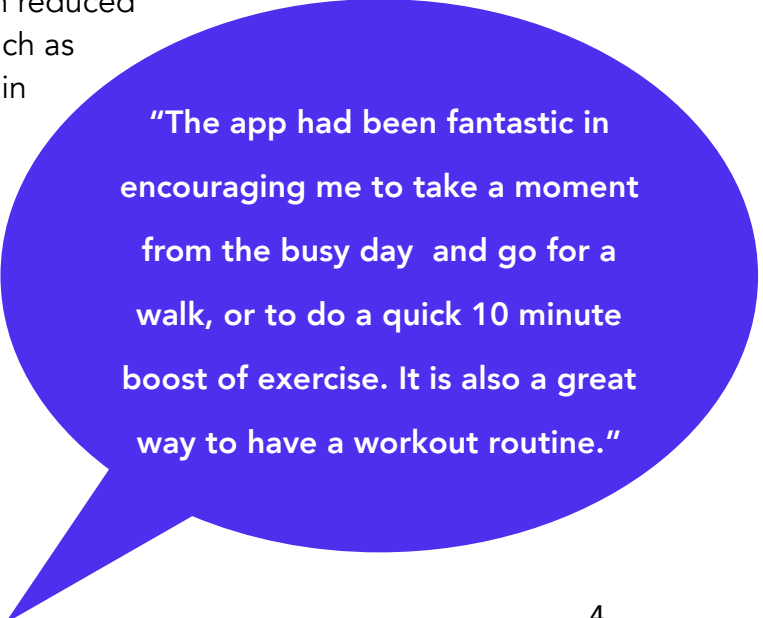
**CONCLUSION:** This evaluation in a real world tier 4 obesity clinical site demonstrates that EXi is an effective tool for prescribing an automated, yet personalised physical activity programme to increase activity levels in people with obesity who have been traditionally resistant to physical activity programmes. Despite some limitation in ongoing health data recorded by the subjects, this evaluation has also demonstrated evidence that increasing physical activity levels with the EXi app translates into BMI and waist circumference reductions when combined with other interventions from the MDT at Barts hospital.

## BACKGROUND

### PHYSICAL ACTIVITY IN OBESITY

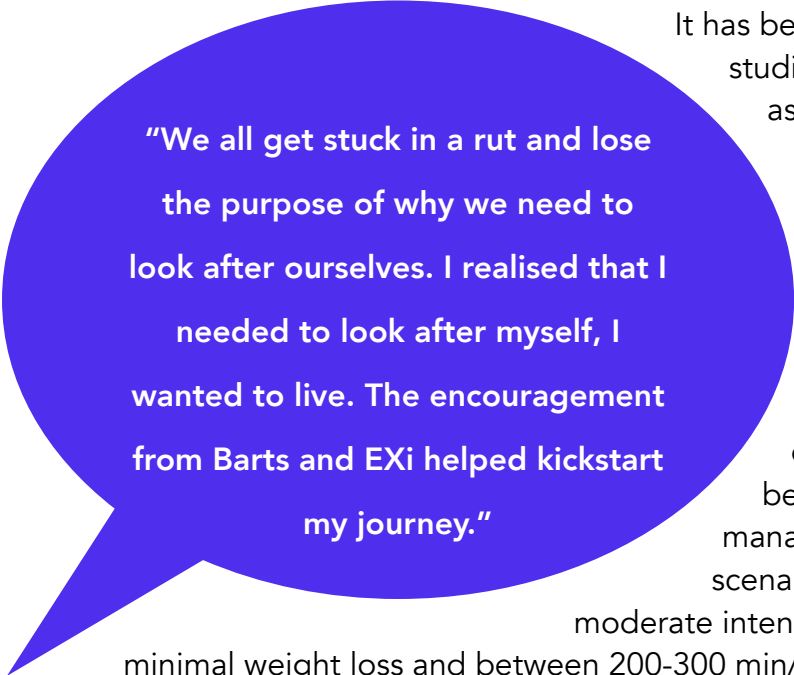
Being overweight or obese are defined by having a body mass index of 25-30 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup>+ respectively with approximately 2/3 of the adult population in the UK (1) and USA (2) being overweight or obese. Obesity is also associated with many other adverse health conditions such as hypertension (3) (4), heart disease (5), diabetes (6), lower limb osteoarthritis (OA) especially of the knee (7), mental health problems (8) and some cancers (9) as well as social and economic deprivation (10) (11) (12) (13). People between the ages of 20-30 and who have a BMI > 45 kg/m<sup>2</sup> will have, on average, a reduced life span of 13 years for men and 8 years for women (14). The COVID-19 pandemic has also brought into sharp focus the relationship between obesity, especially when combined with reduced physical activity, and poor outcomes such as increased hospitalisation and mortality in COVID patients (15) (16). The annual medical costs of obesity have been estimated at £5.1bn in the UK (2011 figures) (17) and \$260bn in the USA (18), with the overall costs to society being many times greater.

Physical activity (PA) as part of a multi-disciplinary team approach including nutrition and psychological support is



**"The app had been fantastic in encouraging me to take a moment from the busy day and go for a walk, or to do a quick 10 minute boost of exercise. It is also a great way to have a workout routine."**

considered to be a key component of obesity management in the healthcare setting. The NICE guidelines in the UK state that physical activity and a physical activity therapist should be provided to patients on Tier 3 and 4 weight management services (14). Other medical interventions that can be considered for people with obesity including pharmacological management (such as orlistat) and bariatric surgery (17). It is also important that for patients to be considered for weight loss surgery, they should have been shown to consistently engage with the MDT plan set for them, including physical activity (14).



"We all get stuck in a rut and lose the purpose of why we need to look after ourselves. I realised that I needed to look after myself, I wanted to live. The encouragement from Barts and EXi helped kickstart my journey."

It has been shown in cross sectional studies that reduced levels of PA are associated with obesity (18) (19), with obesity being both a cause and consequence of reduced PA (20). PA interventions have been used to prevent weight gain, promote weight loss and maintain weight loss. The evidence suggests that there is a dose-response relationship between PA levels and weight management in all 3 of the above scenarios with < 150 min/week of

moderate intensity PA being associated with minimal weight loss and between 200-300 min/week of moderate intensity PA having moderate weight loss (21). It may be difficult for people with obesity who don't reduce energy intake to reach the required levels of PA to reduce weight in a meaningful way. Therefore, the combination of PA and reduced energy intake maximises weight loss in people with obesity (22). A review of weight loss interventions found that programmes which combined diet and exercise resulted in 20% greater weight loss versus diet restriction alone (23); however, this effect is lost when energy intake is severely reduced (21). Exercise also changes the distribution of fat, by reducing the less healthy visceral (abdominal) fat – for some individuals, body weight may stay the same as muscle is built up but the reduction in visceral fat is highly beneficial for health (24).

PA in obese patients should always be considered in terms of its overall health benefits. It may be hard for people with obesity to increase from very low activity levels to 200-300 min/week and failure to meet this goal can be very demotivating. Irrespective of a reduction in weight, PA has been shown to have significant benefits in preventing and managing cardiovascular disease (25), diabetes (26), hypertension (4), lower limb OA (7), mental health (8) all of which are common in people with obesity and also to improve function and quality of

life in people with reduced mobility. On mortality risk, it has been shown that higher levels of PA can negate the increased mortality levels associated with obesity (27).

Currently there are growing reports in the literature suggesting innovative approaches using mobile technologies to promote obesity treatment interventions (28).

However, there is currently a lack of scientific evidence to support exercise prescription in obese adults. For this reason, more research is needed to clarify the effect of a digital intervention in this population in increasing exercise and reducing weight. With this investigation we hope to contribute to closing this research gap.

## **BRIEF DESCRIPTION OF EXi**

EXi is an evidence-based, NHS approved and award-winning app which analyses user health and fitness and prescribes a personalised physical activity programme. Set at exactly the right intensity for each person, the app will help users to safely and gently increase their activity levels and improve their health.

The user can specifically tailor their programme to any number of 23 physical and mental health conditions, such as diabetes, heart disease and depression, with all of the necessary safety features built-in. EXi follows the latest medical guidelines for exercise prescription. Each user is given an individualised goal for each week and is given the option of meeting this goal via either intensity-based minutes of exercise (e.g. 4 days of 15 minutes at low intensity) or step count which is tracked in the background via their smartphone (e.g. 4 days of 6,000 steps).

Activity and health outcome data is delivered directly back to health and fitness professionals in real-time to help inform and plan care, via the secure, penetration tested and GDPR compliant web-based data portal. The information provided includes weekly exercise time, percentage of goals completed, allowing the clinician to have an informed conversation with patients about their exercise programme.

EXi can help obesity services to provide a PA solution for all their patients in an efficient way that fits in to the patient's life. The EXi web portal improves accountability from the patient to the clinical team and allows the patient to demonstrate that they are compliant with the PA programme provided to them, which amongst other benefits, can potentially improve their access to bariatric surgery if indicated. This is unique in prescribed exercise solutions for this group.

## BARTS HOSPITAL TIER 4 BARIATRIC SERVICE

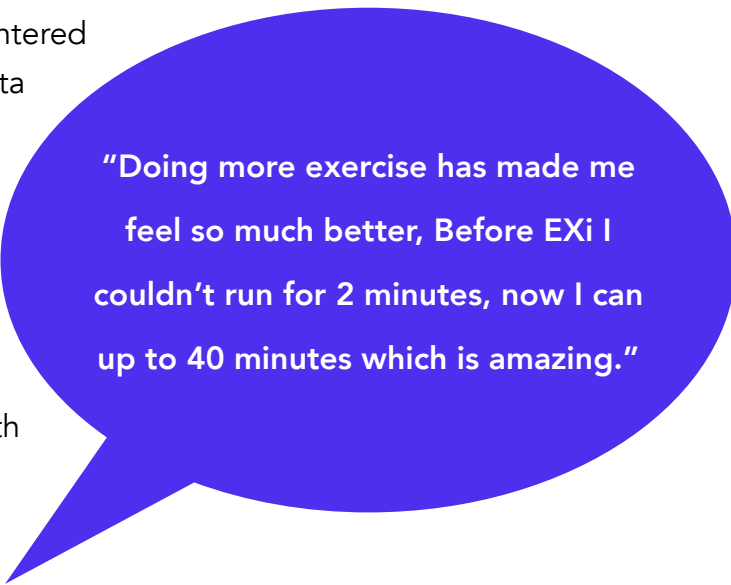
The Barts Hospital runs a busy multidisciplinary tier 4 bariatric service which manages severe and complex obesity patients (including obesity surgery, obesity medicine, specialist weight management programmes, post-surgical and annual follow up). Tier 4 services will offer more specialist and intensive input than tier 3 (14) and deal with the most complex of obesity patients.

The Barts tier 4 team consist of 2 obesity physicians, specialist registrar, dietician and obesity specialist nurse and a pathway coordinator, with the team seeing around 50 patients in total a week. Previous to the introduction of EXi, the service had no provision for formal exercise prescription.

The patients are mostly referred from primary care and are complex patients who need to have a BMI of at least 35 kg/m<sup>2</sup>.

## METHODS

This investigation took the form of a real world observational clinical study. The clinical team contacted eligible participants by phone (due to the coronavirus pandemic) during their usual consultations and discussed exercise and the EXi programme. A referral was then made via secure email to a physiotherapist who then made email contact with the patient with a letter explaining the programme and scheduled in a 10-minute call to discuss. The participants downloaded EXi and then entered their demographic, health and fitness data which was analysed by the EXi programme. EXi produced a digital personalised physical exercise plan lasting 12 weeks. Once on the programme, the physiotherapist would use the EXi data portal to assess each patient's progress and follow up with an SMS and occasionally a phone call every 2-4 weeks.



**"Doing more exercise has made me feel so much better, Before EXi I couldn't run for 2 minutes, now I can up to 40 minutes which is amazing."**

After 12 weeks, the user was referred back to the clinical team at Barts hospital with an update showing the patient’s exercise level and health metrics. The patient could then continue to use EXi indefinitely, but without follow-up from the clinical team.

## SUBJECTS

The target population of this study were obese adults receiving care from the Barts Hospital tier 4 obesity clinic and 71 patients were recruited to the study. Information on gender, age, BMI, waist circumference and co-morbidities was provided directly by the patient via the EXi app. Details of the subjects when they started the EXi programme are included in Table 1 below.

<b>Gender</b>	20 Male, 51 Female
<b>Age (years)</b>	43.99 +/- 12.57
<b>BMI (kg/m<sup>2</sup>)</b>	44.56 +/- 10.51
<b>Waist Circumference (WC) (cm)</b>	119.27 +/- 14.96
<b>Number of co-morbidities (CMs) reported</b> <b>* Note: Co-morbidities are self-reported</b>	Mean = 1.66  (1 has 7 CMs, 1 has 6 CMs, 3 have 5 CMs, 5 have 4 CMs, 11 have 3 CMs, 12 have 2 CMs, 13 have 1 CM and 25 have 0 CMs)
<b>Common co-morbidities</b> <b>* Note: Co-morbidities are self-reported</b>	Depression, stress or anxiety (n=25), Hypertension (n = 24), Type 2 diabetes ( n=16), Osteoarthritis (n=13), Asthma (n=11), Fibromyalgia (n=9), Hyperlipidaemia (n=7), COPD (n=5), Chronic Fatigue (n=4), Metabolic syndrome (n=2), Cardiovascular disease (n=2), Multiple sclerosis (n=1)

Table 1: Subject characteristics at the beginning of the EXi programme.

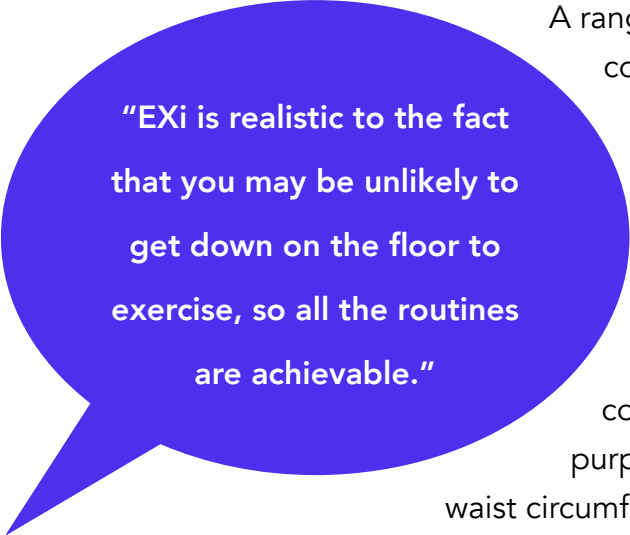


## Inclusion Criteria

- Adults aged under the care of the obesity clinic
- $\geq 18$  years
- Able to engage with physical exercise

## Exclusion Criteria

- Patients reporting functional mobility problems which mean they are unable to leave the house without assistance.
- People who don't have access to an Android (with Android OS 7.0 or above) or iOS smartphone (iPhone 4 or above).



**"EXi is realistic to the fact that you may be unlikely to get down on the floor to exercise, so all the routines are achievable."**

A range of health metric data can be collected via the EXi app which will be personalised dependent on the subject's health and goals. This information is collected initially during app onboarding and then every week during the programme. It is not a requirement that the patient has to complete this information. For the purposes of this evaluation, weight, BMI, waist circumference were monitored.

## OUTCOME MEASURES

The primary outcome measure of this investigation is to determine engagement rates of the subjects with the EXi programme.

### **The following information was captured:**

- The number of referrals to EXi from the obesity clinic
- The number of subjects agreeing to start the EXi programme (as defined by recording an activity in EXi)
- The number of subjects completing 4, 6, 8 and 12 weeks of the EXi programme

- The percentage of those starting the programme who completed 4, 6, 8 and 12 weeks of the EXi programme
- The average percentage of weekly goals completed each week. As the EXi prescription is personalised to each subject, the goals differ for the subjects.
- The average number of weeks completed for all subjects who started the EXi programme (discounting those people who had started in the past 6 weeks who were still engaged with the programme) and the average number of weeks completed for those who have completed the 12-week programme.
- Change in average step count from baseline (taken from available data for the immediate 12 weeks before starting the EXi programme) to an average step count at 4, 6, 8 and 12 weeks.

A secondary outcome measure was to measure changes in weight and body composition metrics in the subjects from the beginning of the programme to completion. This includes weight (BMI) and waist circumference.

## DATA ANALYSIS

Data was downloaded from the EXi web portal in csv form. This allowed the analysis of baseline and weekly exercise, health and engagement data for individual subjects.

### **Data collected:**

- Starting activity levels
- Health conditions
- Exercise goals and percentage of goals completed
- Exercise minutes
- Step count
- Type of activity completed
- Anthropometric data: height, weight, waist circumference
- Other health metrics (not reported in this study): Including blood pressure, resting heart rate, 6-minute walk test, blood sugars and many others.

# RESULTS

## EXERCISE LEVELS AND ENGAGEMENT

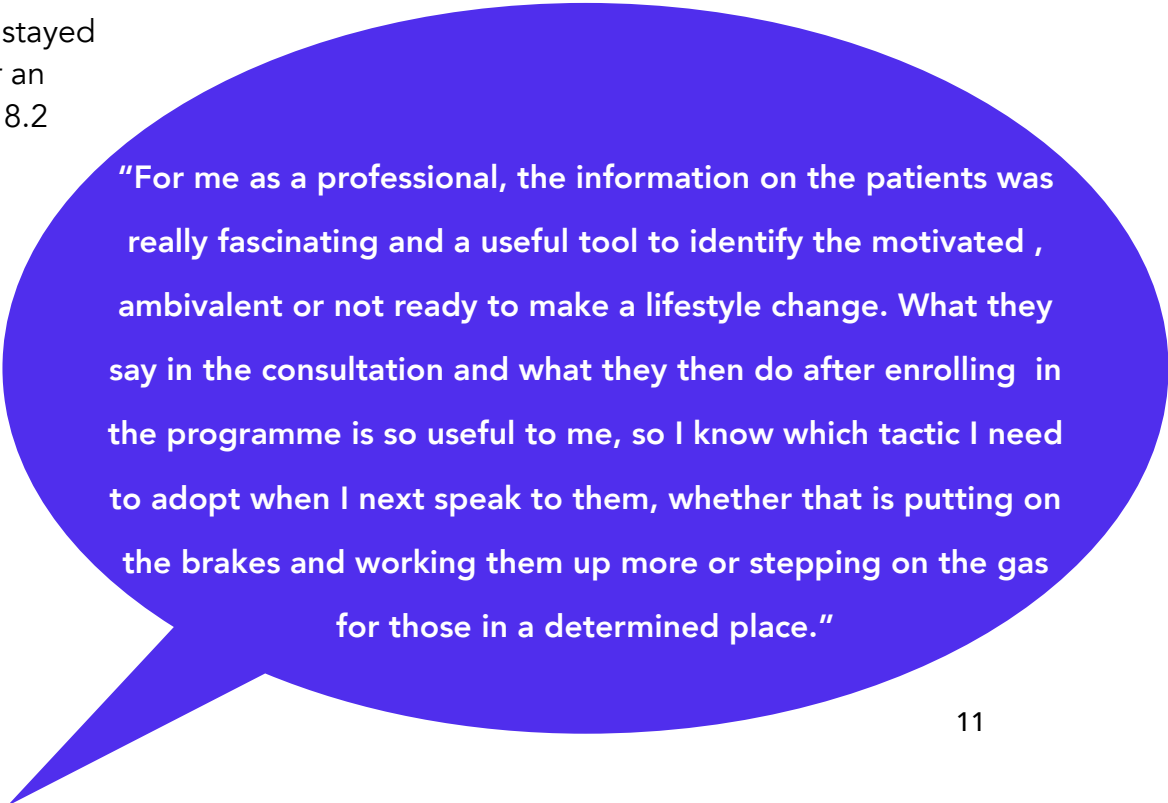
Over the period of the evaluation, 89 patients were referred to EXi from the tier 4 obesity clinic. After email and telephone contact with the subjects, 71 subjects accepted the offer and decided to use the EXi app, recording at least one activity or registered a step count. Below is a table of subjects who remained engaged with EXi at progressive time points.

Week number	Number engaged	Percentage engaged
Week 4	66	92.9%
Week 6	49	69%
Week 8	46	64.7%
Week 12	40	56.3%

Table 2: Subject's engagement with the EXi programme

On average, the percentage of weekly exercise goals completed for the subjects on the EXi programme was 54.6%.

The average time of exercise completed for those on the EXi programme (discounting those people who had started in the past 6 weeks who were still engaged with the programme) was 11.8 weeks and those subjects who completed the 12-week programme stayed engaged for an average of 18.2 weeks.



"For me as a professional, the information on the patients was really fascinating and a useful tool to identify the motivated , ambivalent or not ready to make a lifestyle change. What they say in the consultation and what they then do after enrolling in the programme is so useful to me, so I know which tactic I need to adopt when I next speak to them, whether that is putting on the brakes and working them up more or stepping on the gas for those in a determined place."

## CHANGE IN ACTIVITY LEVELS

Step count data was recorded from users' available data in the previous 12 weeks before beginning the EXi programme. This was then compared against average step count data in weeks 4,6,8 and 12. The results and percentage change are shown in Table 3 below.

Totals	Average steps	Changed from baseline
Baseline	18350	0.0%
Week 4	22497	22.6%
Week 6	25703	40.1%
Week 8	24219	32.0%
Week 12	22775	24.1%

Table 3: Change in participant step count

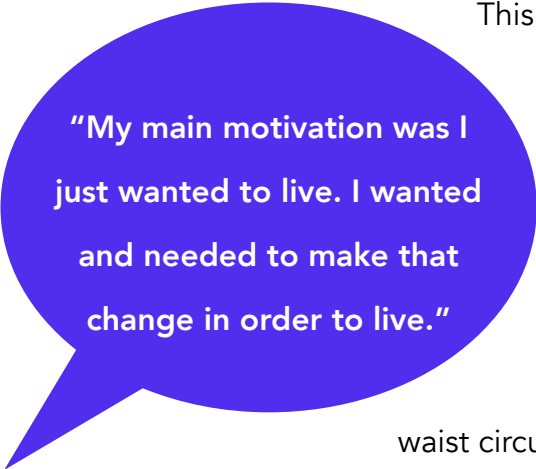
As shown above, there is an increase in step count from baseline levels at all time points.

## HEALTH OUTCOMES

Whilst not a full data set due to not all patients recording their health metrics, we did get pre and post data on waist circumference and weight for 13 patients. This showed a reduction of 2.4kg and a waist circumference reduction of 4.4cm.

# CONCLUSION

Obesity, especially for people who have been referred to a tier 4 obesity service has been linked with many chronic health conditions, poor function and quality of life and early mortality. Physical activity is a key component of the multidisciplinary management of obesity to reduce weight and maintain weight loss. Just as important as PA's effect on weight management is the effect that it has in preventing and managing the associated co-morbidities.



**"My main motivation was I just wanted to live. I wanted and needed to make that change in order to live."**

This evaluation in a real world tier 4 obesity clinical site demonstrates that EXi is an effective tool for prescribing an automated, yet personalised physical activity programme to increase activity levels in people with obesity. Despite some limitations in collecting ongoing health data reported by the subjects, this evaluation has also demonstrated evidence that increasing physical activity levels translates to BMI and waist circumference reductions when combined with other interventions from the MDT at Barts hospital.

The results showed that when people engage on the EXi programme for 6 weeks, there is good continuation of the programme to 12 weeks where it has been demonstrated that behaviour change and habituation of exercise programmes is likely to occur. Furthermore, it was demonstrated that those who complete the 12 week programme stay on for an average of 18.2 weeks, indicating that these users continue to be engaged with the EXi programme even following the completion of the formal 12 week period. More work does need to be done in the first 4-6 weeks to engage people to begin and stay consistent with the EXi programme to allow for the habituation of physical activity and allow noticeable changes in the subject's health, which greatly helps to maintain physical activity in the longer term. EXi currently has behaviour change features such as instant feedback / gratification for users when they complete an exercise, a gold, silver and bronze badge system if patients meet their goals and a personalised, graduated exercise programme at low to moderate intensity which has been shown to be more sustainable than high intensity programmes in this group of patients (29). It has also been shown that exercise programmes that allow people to exercise at home in a way and at a

time that suits them are more likely to be successful than those in a more structured environment (30).

Average activity (as measured by step count) was 24.1% higher at week 12 of the EXi programme compared with the pre-intervention levels. Whilst this doesn't give a measure of the intensity of the exercise being completed, it does provide a consistent way of measuring activity levels from before the start of the EXi programme. The change in activity levels for the 12 weeks of the EXi intervention, shows that EXi is able to achieve and sustain an increase in activity in this cohort of patients, potentially leading to significant health benefits.

The ability for clinicians to be able to view health and exercise data via the EXi portal allowed them to monitor and encourage patients to continue on their journey and review as necessary. It also had the effect of motivating the patient by allowing them to prove that they were engaging with the programme, which isn't possible in traditional care. This accountability is particularly valuable for those who are potentially seeking bariatric surgery as it can help for them to prove compliance with the MDT plan.

The feedback from both the clinicians and patients showed that in most cases, EXi was easy to use and provided an appropriate progressive programme for people who often have very low activity levels prior to the programme and negative views of physical activity / exercise.

## NEXT STEPS

Future research is required to conduct a formal clinical trial in this cohort of patients which will aim to collect more data independently of the EXi app to show changes in weight, changes in health metrics and further questions on attitudes to physical activity / exercise. Having a control group to compare results against is also a priority.

EXi will take the learning from this evaluation from both the patient and clinician side to help improve the EXi app to facilitate even more user engagement in this challenging cohort and to also encourage increased reporting of relevant health metrics.

# PATIENT AND CLINICIAN QUOTES

## Patient 1

"I am so grateful to Barts hospital for recommending the programme and to EXi for accepting me onto it.

I'm now at week 16 since starting on a different way of thinking about my health and can now notice the difference with my day to day movement and activities. Such as the length of time I can stand, ease of getting up out of a chair, walking upstairs, bending down, including my more upbeat positive mood and general wellbeing.

My background of exercise was of someone who has had limited time exercising since school years apart from celebrity exercise DVDs coupled with 'yo-yo' dieting over the many years. Exercise was always in my mind done to lose weight or by those who loved it with a passion... which was not me. My only exercise I enjoyed prior to my accident was walking.

Over the last 10 years since my accident my mobility has worsened and this has had a detrimental effect on not only my weight but also my life. I could see the restricted future I potentially had in front of me looming and I wasn't happy about what was in store for me.

Thankfully I was offered the EXi programme, which builds you up gradually with three levels of intensity: low, medium and high depending on your starting point. Also, there is a gradual increase in minutes and days you do the programme. Starting at low intensity for 10 mins, 3 days per week, building to my current 30 minutes for 5 days per week. Increasing in minutes each week brings you to the recommended 30 minutes per day without realising!

This time my goal is 100% about me improving my mobility, but I'm finding I'm losing weight too without being so focused on what I am eating.

The saying "there is no gain without pain" is true, but the programme allows you to work at your own pace and pain levels with the support of the EXi team. If it's too hard you can step back a week or two and repeat earlier weeks and build up at a slower pace. As long as you keep on the programme you are going in the right direction to being healthier.

I have to use mind over matter on some days but have juggled the programme to suit me. For example my 30 minutes can be made up of several blocks throughout the day, i.e. 10 mins, 5 mins, 10 mins and another 5. The fact that it is an App on your phone means it is to hand whenever you're ready to go. The exercises are easy to follow and unlike a lot of what is available elsewhere EXi is realistic to the fact that you are unlikely to be able to get down on the floor to exercise, so all the routines are achievable. Your targets, performance and scores are logged as data on the App, so you can keep track of how you have progressed, which I found an excellent incentive. Seeing the EXi App on my home screen was a reminder to keep focused on the programme and to work the programme into my day.

It was great to know there was the physiotherapist and medical support available which gave me the confidence that it was ok with my health conditions to do the exercises as it was being monitored through heart rate records etc on the App and regular one to one contact.

This is a brilliant lifeline of a service that is available to those that need the confidence to start exercising at a pace that's designed for them. No gym... just easy fun exercise in the privacy of your own home in your own time. Which was exactly what I needed."

### **Patient 2**

"The app has been fantastic in encouraging me to take a moment from the busy day, and go for a walk, or to do a quick 10-minute boost of exercise. It is also a great way to have a workout routine. For me Sundays and one other day in the week is dedicated to a long workout, and then the rest of the week I keep up the walking and at least 20 to 30 mins of a workout.

It has been a great way to keep active whilst still having a busy day, and I really am enjoying it."

### **Patient 3**

"Doing more exercise has made me feel so much better. Before EXi I couldn't run for 2 minutes, now I can run up to 40 minutes which is amazing.

The whole support from my GP, to Barts and Lewis supporting me along the way helped me stick to my programme.

My main motivation was I just wanted to live. I wanted and needed to make that change in order to live. Living is not just breathing but doing simple things such



as tying up your shoelace with ease, going for a walk with your child without falling breathless, these are things that I couldn't do that easily before EXi.

Also sleeping and breathing better. Before EXi my oxygen saturates were high and would cause me to have restless sleeps. Since losing a bit of weight and exercising more, my Oxygen levels are low and I'm able to sleep much better. I feel that I'm too young to die and this was my main motivation that I kept referring to when I didn't feel like exercising.

I would recommend deciding on a goal that you want to achieve from exercising and refer to that every time you hit a wall or struggle to get going with your exercise."

### **Clinician**

"Patients liked the idea that we could see their progress and the reports came to us. That sort of monitoring was a little push so as not to let us down.

For me as a professional, the information on the patients was really fascinating and a useful tool to identify the motivated, ambivalent or not ready to make a lifestyle change. What they say in the consultation and what they then do after enrolling in the programme is so useful to me, so I know which tactic I need to adopt when I next speak to them, whether that is putting on the brakes and working them up more or stepping on the gas for those in a determined place."

# REFERENCES

1. **NHS Digital.** *Statistics on Obesity, Physical Activity and Diet, England 2021.* 2021.
2. *Prevalence of overweight and obesity in the United States, 1999-2004.* **Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM.** 2006, JAMA, Vol. 295, pp. 1549-55.
3. *The physicians role in prescribing physical activity for the prevention and treatment for essential hypertension.* **Brooks JHM, Ferro A.** 2012, JRSM Cardiovasc. Dis., Vol. 1.
4. *How does exercise treatment compare with antihypertensive medications? A network metaanalysis of 391 randomised controlled trials assessing exercise and medication effects on systolic blood pressure.* **Naci H, Salcher-Konrad M, Dias S et al.** 14, 2019, Br J Sports Med, Vol. 53, pp. 859-69.
5. *Physical activity in the prevention of coronary heart disease: implications for the clinician.* **Varghese T, Schultz WM, McCue AA et al.** 12, 2016, Heart, Vol. 102, pp. 904-909.
6. *Exercise prescription for patients with type 2 diabetes-a synthesis of international recommendations: narrative review.* **Mendes R, Sousa N, Almeida A.** 22, 2016, Br J Sports Med, Vol. 50, pp. 1319-81.
7. *Exercise for osteoarthritis of the knee.* **Fransen M, McConnell S, Harmer AR et al.** 1, 2015, Cochrane Database Syst Rev, Vol. 9.
8. *Walking for depression or depressive symptoms: a systematic review and meta-analysis.* **R Robertson, A Robertson, R Jepson, and M Maxwell.** 2012, Database of Abstracts of Reviews of Effects.
9. *Role of physical activity and sport in oncology: scientific commission of the National Federation Sport and Cancer CAMI.* **Bouillet T, Bigard X, Brami C et al.** 1, 2014, Crit Rev Oncol Hematol, Vol. 94, pp. 74-86.
10. *Social and economic consequences of overweight in adolescence and young adulthood.* **Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH.** 14, 1993, N Engl J Med, Vol. 329, pp. 1008-12.
11. *Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001.* **Mokdad AH, Ford ES, Bowman BA, et al.** 2003, JAMA, Vol. 289, pp. 76-9.
12. *The disease burden associated with overweight and obesity.* **Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH.** 1999, JAMA, Vol. 282, pp. 1523-9.
13. **U.S. Department of Health and Human Services.** *Physical Activity and Fitness, Progress Review, Healthy People 2000.* Public Health Office. Washington (DC) : U.S. Government Printing Office, 1998.
14. **England, NHS.** *Appendix 7: Guidance for Clinical Commissioning Groups (CCG's); Clinical Guidance: Surgery for Severe and Complex Obesity.* 2016.

15. *High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation.* **Simonnet A, Chetboun M, Poissy J, Raverdy V, Noulette J, Duhamel A, Labreuche J, Mathieu D, Pattou F, Jourdain M.** April 2020, *Obesity*.
16. *Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48 440 adult patients.* **Sallis R, Young DR, Tartof SY, et al.** April 2021, *British Journal of Sports Medicine*.
17. *Obesity Identification, assessment and management of overweight and obesity in children, young people and adults.* **National Clinical Guideline Centre.** s.l. : NICE, 2021.
18. *Associations of physical activity with body weight and fat in men and women.* **Ball K, Owen N, Salmon J, Bauman A, Gore CJ.** 2001, *Int J Obes Relat Metab Disord*, Vol. 25, pp. 914–9.
19. *Variables independently associated with self reported obesity in the European Union.* **Martinez JA, Kearney JM, Kafatos A, Paquet S, Martinez-Gonzalez MA.** 1999, *Public Health Nutr*, Vol. 2, pp. 125–33.
20. *Obese Patients Decrease Work Rate in Order to Keep a Constant Target Heart Rate.* **Zuccarelli L, Sartorio A, De Micheli R, Tringali G, Grassi B.** 2020, *Med & Sci in Sport and Ex*, pp. 986-93.
21. *Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults.* **Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, Smith BK.** Feb 2009, *Med Sci in Sport and Ex*, pp. 459-71.
22. **American College of Sports Medicine.** *ACSM's Guidelines for Exercise Testing and Prescription (10th Edition).* [ed.] Riebe D. Philadelphia : Wolters Kluwer, 2018.
23. *Long term weight loss after diet and exercise: a systematic review.* **Curioni CC, Lourenco PM.** 2005, *Int J of Obesity*, Vol. 29, pp. 1168-74.
24. *The effects of exercise on muscle strength, body composition, physical functioning and the inflammatory profile of older adults: a systematic review.* **Liberman K, Forti LN, Beyer I, Bautmans I.** 1, January 2017, Vol. 20, pp. 30-53.
25. *Physical activity in the prevention of coronary heart disease: implications for the clinician.* **Varghese T, Schultz WM, McCue AA et al.** 2016, *Heart*, Vol. 102, pp. 904-9.
26. *Exercise prescription for patients with type 2 diabetes-a synthesis of international recommendations: narrative review.* **Mendes R, Sousa N, Almeida A.** 22, 2016, *Br J Sports Med*, Vol. 50, pp. 1379-1381.
27. *The health risks of obesity have been exaggerated.* **Gaesser GA, Blair SN.** 1, 2019, *Med Sci Sports Exerc*, Vol. 51, pp. 218–21.
28. *Comparison of Smartphone-Based Behavioral Obesity Treatment With Gold Standard Group Treatment and Control: A Randomized Trial.* **Thomas, J.G., Bond, D.S., Raynor, H.A., Papandonatos, G.D., Wing, R.R.** 4, 2019, *Obesity*, Vol. 27, pp. 572-580.

29. *Adherence to exercise prescriptions: effects of prescribing moderate versus higher levels of intensity and frequency.* **Perri MG, Anton SD, Durning PE et al.** 5, 2002, *Health Psychology*, Vol. 21, pp. 452-458.

30. *Effects of group- versus home-based exercise in the treatment of obesity.* . **Perri MG, Martin AD, Leermakers EA et al.** 2, 1997, *J Consult Clinical Psychol*, Vol. 65, pp. 278-285.