Review

How and Why Snacktivity Supports Physical Activity Engagement in Adults With Chronic Low Back Pain: A Realist Review

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How and Why Snacktivity Supports Physical Activity Engagement in Adults with Chronic Low Back Pain: A Realist Review

Running Title: Snacktivity and Chronic Low Back Pain: A Realist Review

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Abstract

Background: Physical activity is a recommended first-line treatment for the management of chronic low back pain, yet adherence to structured exercise often remains poor due to pain, fear, fatigue, and contextual barriers. Snacktivity™, which promotes brief, frequent bouts of movement embedded in daily routines, has emerged as a potentially feasible alternative. However, it remains unclear how, why, and for whom Snacktivity supports engagement in physical activity for people living with chronic low back pain. **Objective:** To develop and refine programme theories explaining how Snacktivity-type interventions support physical activity engagement and related outcomes in adults with chronic low back pain. **Methods:** A realist review was conducted following RAMESES standards. Initial programme theories were developed and iteratively refined through synthesis of quantitative, qualitative, and mixed-methods evidence from Snacktivity and related sedentary-reduction interventions in low back pain and other adult populations in order to test developed programme theories. Evidence was analysed to identify context–mechanism–outcome configurations. **Results:** A total of four studies met the inclusion criteria for Snacktivity-type studies related to low back pain and were included to develop and test the initial programme theories. This was supported by 38 studies that contributed evidence to programme theory refinement. Five refined programme theories were supported. Snacktivity appears to enable engagement by lowering perceived burden and threat rather than eliminating fear, generating mastery experiences that enhance self-efficacy, and reducing symptom interference through brief, distributed activity. Education and coaching components supported meaning-making by reframing movement as legitimate and achievable, while environmental cues and routines promoted habit formation. Psychosocial outcomes (confidence, mood, vitality) and habit formation improved more consistently than performance-based outcomes, and engagement was sustained even when pain or fatigue persisted. **Conclusions:** Snacktivity functions as a participation-enabling intervention rather than a traditional exercise prescription. Its effectiveness in chronic low back pain is explained by psychosocial and contextual mechanisms that support psychological safety, mastery, and habit formation. These findings support a shift from dose-response exercise models toward interventions that prioritise feasibility, meaning, and sustained participation in daily life.

Keywords: Snacktivity; exercise snacking; low back pain; sedentary behaviour; habit formation; self-efficacy; realist review; physical activity

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Introduction

Low back pain (LBP) is the leading cause of disability worldwide, accounting for more years lived with disability than any other health condition across most age groups and regions (Ferreira et al., 2021). Globally, LBP affects approximately 7–10% of the population at any one time, corresponding to over 600 million people, and nearly 70–80% of individuals will experience LBP at some point during their lifetime (Ferreira et al., 2023). The prevalence of LBP has the highest number of cases in the age group between 50-55 years and is more prevalent in women (GBD, 2019). The prevalence of LBP is particularly high in specific occupational groups; for example, estimates among office workers range between 31% and 51% (Akkarakittichoke et al., 2022), with similar rates seen in construction workers (Latza et al., 2000), and health care professionals (Almmari et al., 2025). In the case of health care professionals, nurses have a lifetime prevalence of 82% (Abu Saitoon et al., 2024).

Physical activity and exercise are recommended for the management of LBP (NICE, 2016;2020). Physical activity supports improvements in pain, function, confidence, and long-term self-management for people with LBP (Hartvigsen et al., 2018; Qaseem et al., 2017). Despite these recommendations, adherence to prescribed or structured exercise programmes remains inconsistent, with barriers such as time constraints, fluctuating symptoms, pain sensitivity, fear of pain exacerbation, social factors and low motivation commonly reported (Alschuler et al., 2011; Buchbinder et al., 2018). It is important to note that complex and interacting factors may limit engagement in physical activity, for instance fear of movement has been associated with greater levels of pain during activity and negative associations with specific aspects of quality of life such as social function, roles and physical function (Altuğ et al., 2016).

These challenges have prompted growing interest in alternative ways of promoting physical activity that are more flexible and easier to integrate into daily life. One approach which has been proposed as exercise snacking or Snacktivity™. Snacktivity is a novel "whole-day" approach to physical activity promotion that encourages the accumulation of moderate-to-vigorous activity through frequent, brief (2–5 minute) bouts embedded within everyday routines, rather than through structured or prolonged exercise sessions (Gokal et al., 2022; Daley et al., 2023). Snacktivity represents a potentially promising approach that aligns with guideline recommendations to stay active while addressing common behavioural and contextual barriers to sustained engagement. Further, a recent review identified consistence evidence for improvements in physical function and physiological markers as well as respiratory fitness in adult and older adult populations (Alexe et al., 2025).

To understand this area further it is important to use research approaches which can address the complex problems faced by people with LBP and understand why, how and for whom the Snacktivity intervention works. A realist synthesis is designed specifically to address this (Pawson et al., 2005; Wong et al., 2013;2016). The realist approach focuses on what causes outcomes and equates this to specific contexts (background, situated, or specific conditions) and mechanisms (biopsychosocial, environmental or political that create change) (Rycroft-Malone et al., 2012). This means the processes involved in a realist review go beyond just considering results from randomised control trials, or in this case, just outcomes from Snacktivity interventions for people with LBP.

A theory driven realist review can develop understanding based on other forms of past evidence, and this could include the experience of the condition, for instance, review evidence (Cheung et al., 2025; McMillan and Soundy, 2025) highlights psychosocial considerations for people with LBP, including the importance of understanding emotional responses to the condition and emotional regulation that affects participation and decisions around behaviour. Another example could be understanding how people with LBP respond to physical activity interventions, for instance post exercise soreness or temporary increases in pain may require consideration (Comachio et al., 2025). Further, there is the need to consider other factors such as confidence, fear of movement, pain catastrophising or depression and the ability to function, and within this, self-efficacy has been identified as a mediator of psychosocial factors and future pain and disability (Alhowimel et al., 2021). Other factors include social identity, emotional complexity and relational dynamics, culture and ethnicity or access to systems and these factors often receive less consideration despite their

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importance (Mescouto et al., 2022). The role of education or psychologically-informed treatments like cognitive behavioural therapy cannot be ignored for their potential impact and value in understanding why Snacktivity interventions with specific elements may be more effective (Ho et al., 2022). Education, motivational interviewing, activity or goal setting as a part of coaching were well received by people with LBP (Amorim et al., 2019). Finally, understanding broader evidence could help identify causal mechanisms, for instance, reviews on similar or related populations who have undertaken Snacktivity interventions may provide evidence for biopsychosocial benefits or allow challenge to theory (Jones et al., 2024).

In summary, using a realist review to go beyond basic interventional information and consider contextual and mechanistic information that creates change will contribute to the understanding of how, when and for whom the Snacktivity intervention works. To the best of the authors knowledge, only one past realist review (Wood et al., 2024) has been conducted which aimed to understand the behavioural mechanisms by which exercise creates change in outcomes of adherence, engagement and clinical outcomes for patients with LBP. Beyond this, no past realist review has considered Snacktivity for LBP and therefore further review-based research is needed.

Methods

A realist review was undertaken and adhered to the traditional five steps (Pawson et al., 2005) including; (1) identification of scope and initial program theories (2) searching for evidence, (3) appraisal of primary studies and extraction of data, (4) synthesis of evidence and drawing of conclusions, and (4) dissemination, implementation and evaluation. The review was registered with PROSPERO before commencing: CRD420261356919. Results are reported according to the Realist and Meta-narrative Evidence Syntheses (RAMESES): Evolving Standards guidance (Wong et al., 2013;2016).

Step 1. Program theory development

The scope of the current realist review was to consider and develop ideas for how, why and for whom Snacktivity interventions work when considering individuals with LBP. This was undertaken by developing initial program theories (IPTs). These theories provide information around the context (C), mechanism of action (M) and outcomes (O). Five initial IPTs were identified and included:

IPT 1: Snacktivity supports engagement in physical activity and improves outcomes by reducing perceived threat and fear. The CMO for IPT1 is that brief flexible bouts of physical activity (C) reduce the perceived physical or emotional threat or fear of activity and generate feelings of possibility rather than uncertainty (M) and this will provide a willingness to participate (O).

IPT 2: Snacktivity enhances self-efficacy through repeated mastery experiences. By achieving successful achievable bouts of physical activity and being able to integrate this into daily life (C), individuals will experience enhanced self-efficacy from mastery experiences (M) and this will lead to increase confidence and contribute to sustained functional outcomes (O).

IPT3: Snacktivity minimises the impact of post-exercise pain and soreness. Brief sessions of concentrated activity (C) mean individuals will experience fewer severe symptom exacerbations (M) which therefore limits negative reinforcement and avoidance behaviours allowing continued participation (O).

IPT4: Education and coaching elements help reconsider the value of small movement and motivate participants. Snacktivity interventions can incorporate education and motivational interviewing or coaching related elements (C) and this may support participants to reframe understanding of activity benefit and increase motivation (M) which can lead to greater adherence and value of activity (O).

IPT5: Environments or daily routines that allow or are conductive to spontaneous movement opportunities (C) help and allow autonomy and habit formation (M) which will increase the effectiveness of the intervention (O).

These IPTS were supported by past evidence. See Table 1 for a summary of this supporting evidence.

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Table 1. Identifying specific mechanisms supporting each IPT proposed.

IPT	Key Mechanisms producing better engagement, health and adherence outcomes
1	Low back pain threat and fear • Fear of movement acts as a barrier influencing behaviour and increases avoidance (Alhowimel et al., 2021; Cheung et al., 2025; George et al. 2022; Pincus et al., 2002). • Emotional responses (fear, uncertainty, threat appraisal) shape decisions about movement and participation in people with chronic LBP (Cheung et al., 2025; McMillan & Soundy, 2025)
	Exercise format and threat • Interventions that reduce perceived demand or threat (e.g., graded exposure, adaptable activity) improve initial engagement in people with LBP (George et al., 2022; Comachio et al., 2025)
	Snacktivity and intermittent activity • Snacktivity and intermittent low level physical activity appear acceptable and feasible, especially for inactive adults, likely due to reduced physical and psychological burden (Jones et al., 2024)
2	Importance of self-efficacy in LBP • Self-efficacy mediates the relationship between psychosocial risk factors and future pain/disability in chronic LBP (Alhowimel et al., 2021; Holden et al., 2010) • Confidence to move is a key determinant of long-term function and activity maintenance (Bandura, 1997; Foster et al., 2018)
	The value of mastery experiences • Repeated achievable tasks are the strongest source of self-efficacy development (Bandura, 1997)
	Snacktivity logic • Frequent, achievable activity bouts embedded in daily life create repeated opportunities for success (Jones et al., 2024) • Small, integrated movement episodes improve perceived capability in inactive adults (Stamatakis et al., 2022)
3	The importance of post exercise pain • Post-exercise soreness or temporary pain increases can reinforce fear and avoidance in people with LBP (Comachio et al., 2025; Bunzli et al., 2013) • Negative pain experiences following activity reduce future engagement (Hartvigsen et al., 2018; Vlaeyen & Linton, 2012)
	Activity Dosing • Gradual, dosed physical activity reduces symptom flares and improves adherence compared with high-load exercise sessions (Geneen et al., 2017; Foster et al., 2018)
	Snacktivity plausibility • Intermittent activity may distribute load more evenly, reducing symptom flares (Jones et al., 2024)
4	The value of psychological and educational interventions • CBT-informed and education-based interventions improve engagement and physical function for people with chronic LBP (Ho et al., 2022)
	The value of education and coaching • Education, motivational interviewing, and goal setting are well received and support activity engagement in LBP (Amorim et al., 2019) • Meaning-making (understanding why to move) is critical to behaviour change (Keefe et al., 2018; Michie et al., 2014)
	The compatibility with Snacktivity • Snacktivity is often accompanied by simple messaging, cues, or coaching rather than formal exercise instruction (Jones et al., 2024)
5	Environment and physical activity

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• Environmental affordances strongly influence physical activity behaviour (Ding et al., 2020; Sallis et al., 2016)
Habit formation
• Repeated behaviours in stable contexts promote automaticity and habit formation (Lally et al., 2010; Gardner et al., 2012)
Autonomy
• Autonomy is associated with intrinsic motivation and long-term adherence (Deci & Ryan, 2000)
The compatibility with Snacktivity
• Snacktivity relies on spontaneous, routine-embedded movement opportunities (e.g., stairs, chores) (Jones et al., 2024)

Step 2: Searching for Evidence

The search processes blended the requirements of realist inquiry with the processes required by the PRISMA 2020 checklist (Page et al., 2020) and PRISMA-S (Rethlefsen et al., 2021) search tool.

Eligibility Criteria

The participant, intervention, outcome and study design (PICOS; Schardt et al., 2007) acronym was used to identify the following eligibility criteria:

P - Population

Studies were included if they included; Adults (18+) with LBP (acute, subacute, chronic, persistent, non-specific). Mixed musculoskeletal samples if LBP data were extractable. Healthy adults only if the study provides transferable mechanistic insights relevant to Snacktivity (e.g., feasibility, acceptability, habit formation). Studies were excluded if they involved children or adolescents, athletes (unless there was an identification of BLP), surgical LBP populations (unless micro-bouts were a part of rehabilitation process), specific causes of LBP (for instance fibromyalgia or radiculopathy).

I - Intervention

Studies were included if they involved: Snack-based physical activity, defined as short, frequent bouts of movement (e.g., 1–5 minutes), including: exercise snacks, microbouts, movement breaks, sedentary interruptions, brief activity breaks, accumulated micro-exercise, Interventions that function like Snacktivity even if not labelled as such (e.g., hourly movement prompts, micro-mobility tasks). Interventions were excluded if they included longer or structured exercise sessions (e.g., 30–60 min workouts) without a microbout/Snacktivity component. General physical activity interventions with no short-bout or sedentary-break element were excluded. Pharmacological, surgical, or passive treatments (unless combined with Snacktivity) were excluded. High-intensity interval training (unless delivered as micro-bouts) was also excluded as were interventions that were purely educational with no movement component. The following intervention settings were included; clinical settings (physiotherapy clinics, community settings, workplace settings, home-based interventions and digital/app-based interventions.

C- Control

Studies were included whether they had a control group or not. Controls could be active or inactive.

O – Outcomes

Studies were included if they provided experiential, perceptual, or explanatory data, such as: experiences of using Snacktivity, perceptions of feasibility, acceptability, usefulness, barriers and facilitators, motivation, adherence, engagement, behaviour change processes (self-efficacy, habit formation, identity, fear reduction), mechanistic insights relevant to CMO patterns, perceptions of pain, movement confidence, or functional change, physiological or functional outcomes only if linked to mechanisms or context. Studies were excluded that provided no insight into acceptability, feasibility or behavioural change and did not contribute to the CMO development.

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S - Study Design

The following design types were included; qualitative studies (interviews, focus groups, ethnography, thematic analysis), quantitative studies reporting (RCTs, feasibility trials, pilot studies, observational studies), mixed-methods studies, process evaluations, feasibility and pilot studies, observational studies with experiential data, randomised control trials or experimental research.

O - Other

Studies were included if they could provide data that can inform contexts, mechanisms, or outcomes e.g., offer insight into how and why Snacktivity works (or doesn't) or contribute to developing or refining the IPTs and offer data on motivation, capability, opportunity, identity, habit formation, self-efficacy, graded exposure, movement confidence or environmental/contextual influences. Publication types included peer review journals only. English only studies were identified

Information Sources and Search Strategy

A comprehensive and iterative search strategy was developed to identify evidence capable of informing the development and refinement of IPTs within a realist review framework. Consistent with realist methodology, the search aimed to identify diverse sources of data that could contribute to the understanding of CMO associated with Snacktivity-type physical activity interventions in adults with LBP, rather than being restricted to effectiveness-focused trials alone.

Information Sources

The following electronic databases were searched from inception to April 2026: MEDLINE (via PubMed), Embase, CINAHL, PsycINFO, Scopus and Web of Science Core Collection. These databases were selected to ensure coverage of rehabilitation, physical activity, behavioural science, psychology, and qualitative health research. Reference list screening and forward citation tracking of included studies and key reviews were undertaken to identify additional relevant papers not captured by database searching, which is consistent with realist and PRISMA-S guidance.

Search Concepts and Strategy Development

The search strategy was structured around four core concepts derived from the eligibility criteria and IPTs. Search terms were developed iteratively with input from existing review evidence, theoretical frameworks relevant to physical activity behaviour, and pilot scoping searches. Both controlled vocabulary (e.g., MeSH terms) and free-text terms were used. Truncation, phrase searching, and synonym grouping were applied to maximise sensitivity.

Medline terms used for data base searching
Population:
(low back pain OR back pain OR lumbar pain OR nonspecific low back pain
OR persistent low back pain OR chronic low back pain
OR chronic musculoskeletal pain OR musculoskeletal pain
OR chronic pain OR persistent pain
OR arthritis OR rheumatoid arthritis OR osteoarthritis
OR chronic disease OR long-term condition*
OR cardiometabolic disease OR metabolic syndrome OR type 2 diabetes
OR cancer survivor* OR cancer-related pain
OR chronic respiratory disease OR COPD
OR older adult* OR ageing OR frail* OR pre-frail
OR physically inactive adult* OR sedentary adult*)
Intervention:
(snacktivity OR "exercise snack*" OR microbout* OR "movement break*" OR "activity break*" OR "sedentary break*"

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OR "brief physical activity" OR "intermittent physical activity" OR "accumulated physical activity" OR "micro exercise" OR "short bouts of exercise")

Mechanisms and behavioural processes
(self-efficacy OR mastery OR confidence
OR fear OR "fear of movement" OR kinesiophobia
OR pain-related fear OR threat appraisal
OR motivation OR engagement OR adherence
OR habit formation OR habit* OR automaticity
OR autonomy OR capability OR identity
OR psychological safety OR perceived burden
OR meaning-making OR reframing
OR behaviour change OR acceptability OR feasibility
OR tolerance OR pacing OR symptom exacerbation)

Study design
(qualitative OR interview* OR focus group* OR mixed-method* OR process evaluation
OR feasibility OR pilot OR observational OR realist OR experimental)

Figure 1 an example search strategy.

Screening and Selection Process

A team of four reviewers independently searched the databases and uploaded records into Covidence© systematic review management software. Screening and study selection were undertaken within Covidence and required two independent reviewers at each stage (title/abstract screening and full-text review). Disagreements were resolved through discussion in team meetings (Higgins et al., 2022).

Study inclusion decisions were guided by their potential contribution to theory development (Pawson et al., 2005; Wong et al., 2013; 2016), specifically whether a study could inform understanding of how, why, for whom, and under what circumstances Snacktivity-type interventions may influence physical activity behaviour in adults with low back pain (LBP). Initial programme theories were developed from studies focused on adults with LBP and were subsequently tested and refined using evidence from Snacktivity-related studies conducted in other adult populations.

Data Extraction

During the review process, a two-stage inclusion strategy was applied. First, studies involving adults with LBP were included to support the development of initial programme theories. Once these initial programme theories were established, additional studies involving other adult population groups were identified and included to test, refine, and extend these theories.

Data extraction was undertaken independently by two reviewers. A standardised data extraction form was piloted and then applied consistently across both the LBP-specific studies and the subsequent non-LBP studies.

Extracted information included study identification details, health condition or population classification, country, setting, sample size and gender distribution, age, ethnicity (where reported), socioeconomic and education characteristics, study design, and study aims. In addition, data were extracted on evidence relevant to core intervention components, mechanisms, and outcomes that could inform programme theory development.

Outcome-related evidence was extracted across the following domains:

- Reductions in sitting time and/or sedentary behaviour;
- Changes in light physical activity;
- Habit-related outcomes (e.g., standing more frequently, breaking up prolonged sitting);

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- Quality-of-life outcomes;
- Pain-related outcomes;
- Confidence or self-efficacy outcomes;
- Mood, energy, or fatigue outcomes;
- Life satisfaction outcomes; and
- Sleep-related outcomes.

Data Synthesis

For studies involving adults with LBP, narrative synthesis techniques of quantitative evidence (Popay et al., 2006) was undertaken to summarise outcome patterns across domains and to support refinement of the initial programme theories. In parallel, a qualitative thematic analysis was conducted to identify key barriers and facilitators influencing engagement with Snacktivity-type interventions. The quantitative evidence was identified with a level of evidence rating from the Oxford Centre for evidence based medicine (OCEBM, 2011). Evidence was graded down based on study quality, imprecision, indirectness (where study PICO did not align with the review PICO), inconsistency between studies, or where absolute effect sizes were very small. Evidence was graded up where large or very large effect sizes were observed. Judgements were made transparently and justified narratively for each outcome domain.

Refined programme theories were subsequently tested against evidence from studies conducted in other adult population groups. Evidence from these studies was summarised using a matrix-based approach, enabling comparison of how the initial programme theories operated across different contexts and populations.

Qualitative evidence from non-LBP studies was analysed using a framework analysis (Gale et al., 2013), informed by the initial thematic structure, to examine whether previously identified barriers and facilitators were present and to identify any additional contextual influences relevant to Snacktivity engagement.

Results

Search Output

A total of four articles met the inclusion criteria. However, from the full text exclusions other studies identified that then could be included for the refinement of programme theories. See the PRISMA flow diagram in Figure 1.

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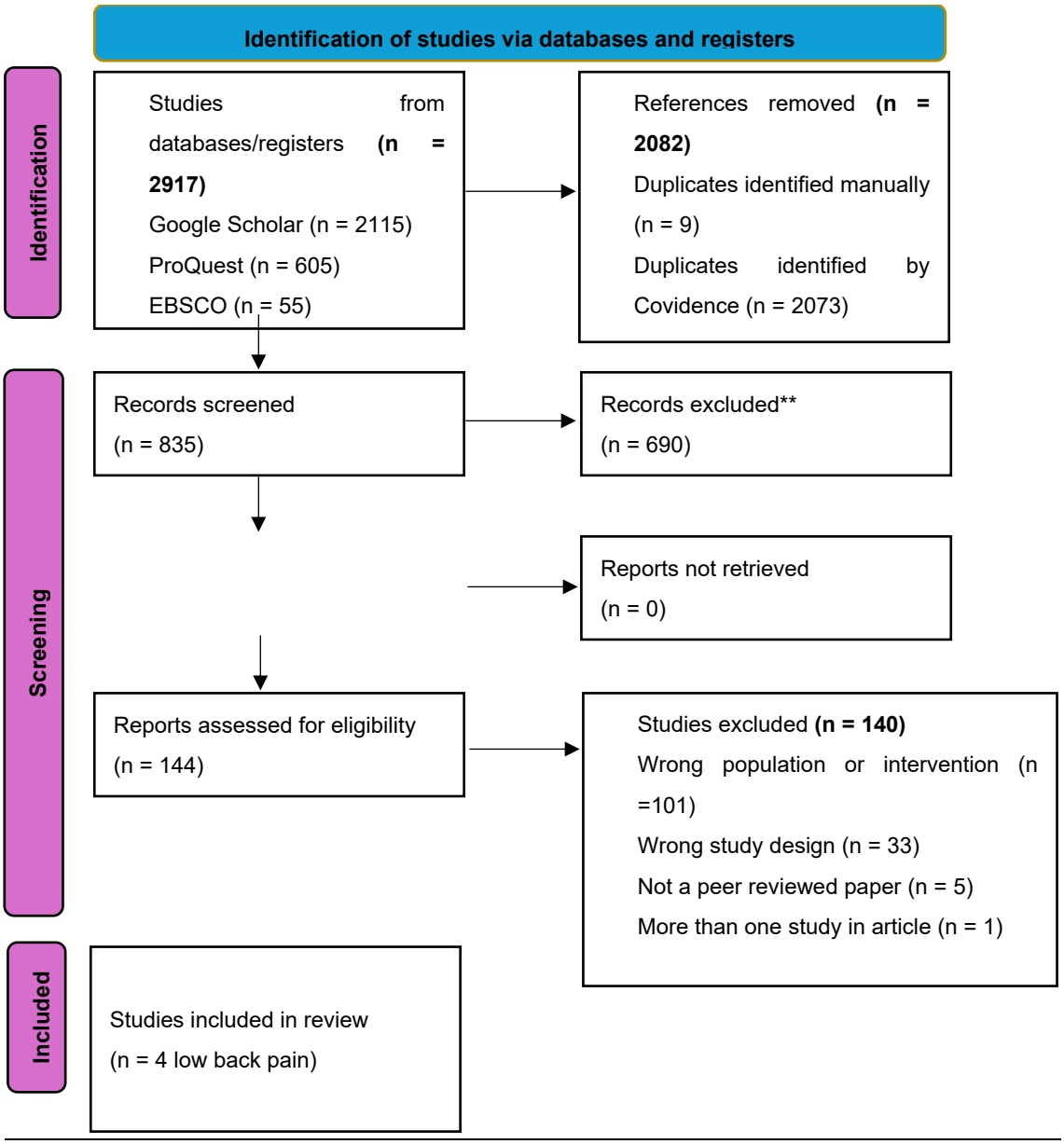

Participant Demographics

Snacktivity Interventions and LBP

Four studies were included; Barone Gibbs et al. (2018), Hergenroeder et al. (2022). Ellingson et al. (2026) and Lansing et al. (2021). Two articles related to the same study reported outcomes on low back pain and disability; the original report (Barone Gibbs et al., 2018) and then an article (Hergenroeder et al., 2022) which reported on secondary outcome measures of presenteeism, health related quality of life, mood, productivity and sleep. A third study was identified (Ellingson et al., 2026) which reported on physical activity, pain symptoms, depressive symptoms, compliance, quality of life and sedentary habits. The final study by Lansing et al. (2021) identified qualitative findings together with actively, health, habit questionnaires as well as physical activity monitoring. All studies were undertaken in the USA with three being randomised controlled trials and one as a pre-experimental trial (Lansing et al., 2021). Two studies (Gibbs et al., 2018; Hergenroeder et al., 2022) were stratified to groups by levels of disability (ranges of scores from the Oswestry Disability Index)and included a total of 27 participants (21 female, 6 male) with an average age of 52 (SD 11) years. Ellingson et al., (2026) included a total of 37 individuals (25 female, 12 male) with had an average age of 40.2 (SD 9.9) years for the intervention group and 41.1 (10.9 SD) years for the control

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group. Lansing et al., (2021) included a total of 20 people into the intervention group but only reported demographics for the 11 interviewed participants (5 female and 6 male) which had an average age of 42 (IQR: 32;45) years.

Hergenroeder et al. (2022) reported the ethnicity of participants as white (n=19/24), black (n=2/24) or Asian (n=1/24). Within this sample more people had a Master's or doctoral degree (n=13/24), than Bachelor's degree (n=6/24) and even less with college experience or associated degree (n=5/24). Ellingson et al. (2026) also reported that most participants were white 15 (79%) in the intervention group and 16 (89%) in the control group. Education was reported and 17 participants (89%) in the intervention group had a College degree and 15(83%) in the control group also had a College degree (Ellingson et al., 2026). Lansing et al. (2021) reported that most participants were white (9/11, 82%) with four participants holding a higher degree (4/11, 36%). Thus across the total sample, the participants mainly represented white females mostly with a college degree.

Two studies (Barone Gibbs et al., 2018; Hergenroeder et al., 2022) used an intervention which had active elements of bimonthly behavioural counselling, a sit to stand desk, a wrist worn activity promoting device, and cognitive behavioural therapy for LBP. A similar format was employed by Ellingson et al. (2026) which utilised a health coach to provide motivational intervening with a focus on breaking up and reducing sedentary behaviour, an education booklet was used to provide informational support, and internal and external cues for breaking up behaviour were identified e.g., if the activity monitor prompts me to stand, I will get a drink of water or walk the stair case for 30 seconds. A Fitbit was used to identify step related goals and support the exercise snacking approach. Lansing et al. (2021) utilised a Fitbit, motivational interviewing, and the main task was supported by prompts of when to accumulate small numbers of steps. All studies used prompts and an activity device with some form of counselling motivational guidance.

Narrative Synthesis of Outcome Measures

Each outcome measure tested to help refine the programme theories was identified and a synthesis of evidence is presented and supported by certainty assessment level. See Table 2 for a summary of the evidence.

Outcome domain	Contributing studies	Direction & consistency of effects	Effect size	OCEBM level	Certainty judgement	Reasons for rating (with supporting studies)
Self-reported sedentary behaviour (sitting time)	Barone Gibbs et al. (2018); Lansing et al. (2021); Ellingson et al. (2026)	Consistent reductions across studies; strongest effects for work and screen time	Moderate to large; statistically significant between-group effects in one RCT	**Level 2**	**Moderate certainty**	Upgraded due to consistent direction of effect and large, statistically significant between-group reductions in sitting time (Barone Gibbs et al., 2018); downgraded for reliance on self-reported outcomes (Lansing et al., 2021; Ellingson et al., 2026).
Objectively measured sedentary time	Ellingson et al. (2026); Lansing et al. (2021)	Directionally favourable but inconsistent and often non-significant	Small to moderate; wide confidence intervals	**Level 3**	**Low certainty**	Downgraded for imprecision due to small sample sizes and wide CIs (Ellingson et al., 2026); downgraded for inconsistency between self-report

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						and device-based outcomes (Lansing et al., 2021).
Objectively measured physical activity	Barone Gibbs et al. (2018); Ellingson et al. (2026); Lansing et al. (2021)	Small, inconsistent changes; largely non-significant	Small	**Level 3–4**	**Low to very low certainty**	Downgraded for very small and non-significant effects (Ellingson et al., 2026; Barone Gibbs et al., 2018); downgraded for indirectness as MVPA was not the primary intervention target (Lansing et al., 2021).
Habit formation / behavioural automaticity	Ellingson et al. (2026); Lansing et al. (2021)	Highly consistent between-group effects across all habit outcomes	Moderate to large; clinically meaningful	**Level 2**	**Moderate certainty**	Upgraded due to consistent moderate-to-large between-group effects on sitting, standing, and breaking up sitting habits (Ellingson et al., 2026); supported by convergent qualitative and quantitative evidence of habit change (Lansing et al., 2021).
Pain and disability	Barone Gibbs et al. (2018); Ellingson et al. (2026)	Consistent improvements in disability; pain intensity changes modest	Moderate to large for disability	**Level 2–3**	**Low to moderate certainty**	Upgraded due to statistically significant and clinically meaningful reduction in Oswestry Disability Index in an RCT (Barone Gibbs et al., 2018); downgraded for imprecision and limited replication of disability outcomes (Ellingson et al., 2026).
Quality of life & psychosocial outcomes	Ellingson et al. (2026);Hergenroeder et al. (2022)	Consistent improvements in physical health, energy, social functioning	Moderate to large	**Level 2–3**	**Moderate certainty**	Upgraded due to consistent moderate-to-large effects on SF-36 physical health, energy/fatigue, and PGIC (Ellingson et al., 2026; Hergenroeder et al., 2022); downgraded for small samples and selective statistical significance.
Sleep outcomes	Hergenroeder et al. (2022)	Significant improvement	Moderate	**Level 3–4**	**Low certainty**	Downgraded for single-study

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	in sleep disturbance only	evidence and imprecision (small sample); downgraded because effects were limited to sleep disturbance rather than global sleep quality (Hergenroeder et al., 2022).

Note: Cis = Confidence intervals.

Sedentary Behaviour and Physical Activity Outcomes

Self-Reported Sitting Time

Across studies, self-reported sitting consistently decreased following Snacktivity interventions. Lansing et al. (2021) reported large median reductions in: weekday sitting (−2.8 hours/day), weekend sitting (−2.0 hours/day), total sitting time (−2.6 hours/day). Similarly with slightly different measures, Ellingson et al. (2026) showed substantial within-intervention reductions in: occupational sitting (−73 min/day), leisure screen time (−82 min/day), total sedentary time (−153 min/day). Between-group differences favoured the intervention but did not reach statistical significance. Finally, the study by Barone Gibbs et al. (2018) demonstrated statistically significant between-group reductions in sitting: −1.4 hr/day total sitting ($p = 0.02$, $d = 0.78$) and −1.5 hr/day work sitting ($p < 0.001$, $d = 1.36$).

Synthesis of evidence:

Level 2 evidence with moderate certainty was identified for self-reported measured of sedentary behaviour. This suggests that Snacktivity reduced sedentary time including reduced self-reported sitting, particularly workplace and screen-based sedentary time, with moderate to large effects identified.

Objectively Measured Sedentary Time and Activity

Objective measures showed smaller and more variable effects. Lansing et al. (2021) found minimal objective change in sitting time and prolonged sitting bouts, despite large self-reported reductions. Ellingson et al. (2026) showed a clinically relevant but non-significant reduction in prolonged sedentary bouts (−53 min/day). Although Barone Gibbs et al. (2018) did not include device-based sedentary behaviour as a primary outcome, the study demonstrated clear behavioural change, with participants reporting reductions of approximately 1.4–1.5 hours per day in sitting time compared with controls.

Synthesis of evidence:

Level 2 evidence with low certainty was identified for objective measures of sedentary time. Snacktivity appears to influence how and where people sit more than total objectively measured sitting time, suggesting behaviour is redistributed across contexts rather than eliminated.

Objectively Measured Physical Activity

Moderate to vigorous physical activity showed small or non-significant increases across studies: Ellingson et al. (2026) identified a very small but non-significant change of +1.6 min/day. Barone Gibbs et al. (2018) identified a greater change of +56 min/week ($d = 0.32$,), but this was also non-significant: Lansing et al. (2021) identified a nonsignificant increase in light activity and steps (+555 steps/day; IQR: -761-2169 steps/day).

Synthesis of evidence:

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Level 3-4 evidence with low to very low certainty was identified for objectively measured physical activity. Snacktivity appears to primarily modify sedentary patterns and light activity, not sustained moderate to vigorous physical activity.

Habit Formation and Behavioural Automaticity

Habit outcomes showed the most consistent and robust intervention effects. Between group analysis identified consistent differences. Lansing et al. (2021) identified the following significant outcomes including standing up more frequently (+13 times/day), breaking up prolonged sitting (+16 times/day), and reduced "sitting when could stand" (−12 times/day). Ellingson et al. (2026) demonstrated moderate-to-large between-group effects for: sitting habit reduction (g = 0.71 [follow up] – 0.84 [post intervention]), standing habit formation (g = 0.64 [follow up]–0.76 [post intervention]) and breaking up sitting habit (g = 0.74–0.84)

Synthesis of evidence:

Level 2 evidence with moderate certainty of was identified for habit formation and behavioural automaticity evidence. Snacktivity interventions produce potentially meaningful habit change. This is based on effect size change identified as well as evidence that such changes translate to meaningful behavioural change. (Gardner et al., 2012) and the number of times prologned sitting is reduced is important (Dunstan et al., 2012), even when changes in total sitting time are modest. Habit change appears to be a key mechanism of action.

Health-Related Outcomes

Pain and Disability

Two studies identified a reduction of disability following the intervention. Barone Gibbs et al. (2018) identified a significant reduction in LBP related disability based on a −8 points (d = 0.73) change on the Oswestry Disability Index. Ellingson et al. (2026) identified an improvement in quality of life within intervention groups and a clinical meaningful but non-significant change in SF-36 bodily pain subscale at post (g=0.81) and at follow up (g = 0.70).

Synthesis:

Snacktivity yields improvements in pain-related quality of life and disability, even when pain intensity itself changes modestly.

Quality of Life and Psychosocial Outcomes

Ellingson et al. (2026) identified significant changes within sub-domains of the SF-36. The SF-36 Physical Health showed large, clinically meaningful effects (g = 0.85 [at follow up]–0.95 [post intervention]) and the global perceived change scale (perception of condition over time) also showed very large effects (g = 1.14 [at follow up]–1.44 [post intervention]). Hergenroeder et al. (2022) identified significant improvements in the following SF-36 questionnaire sub-domains: energy/fatigue (d = 0.84), social functioning (d = 0.62) and SF-36 pain (d = 0.48). Moderate effects were also identified from the SF-36 emotional role limitations (how emotions affect ability to carry out daily role) (d = 0.56). Hergenroeder et al. (2022) identified some relevant effect sizes from the profile of mood state questionnaire, a near moderate but non-significant change in total mood disturbance (p=0.266, d=0.42) and a non-significant moderate effect for esteem-related (confidence, capability, successful, proud) affect (d = 0.65). Finally, the health and work questionnaire resulted in a non-significant but moderate effect for personal life satisfaction (d = 0.49) and again, a non-significant but moderate effect for impatience/irritability (how easily annoyed, inpatient or snappy, links to pain fatigue stress and coping) (d = 0.64).

Synthesis:

Snacktivity interventions consistently appear to improve function-focused and psychosocial outcomes, particularly energy, confidence, emotional functioning, and perceived life satisfaction, even when symptom change is modest.

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Sleep

Hergenroeder et al. (2022) identified a significant improvement on the Pittsburgh Sleep Quality Index sleep disturbance domain (the ability sleep through the night and not being disturbed or waking up too early (d = 0.77), with no change in the global sleep score.

Synthesis:

Snacktivity may improve influence sleep continuity and night-time disruption, rather than total sleep quality.

Qualitative Findings: Factors Influencing Outcomes

Qualitative data (Lansing et al., 2021; Barone Gibbs et al., 2018) provides some contextual and mechanistic information of why and when interventions work. Barriers were identified by both studies as; (a) work demands requiring sustained sitting (b) time pressure and cognitive focus, (c) social norms discouraging standing, (d) environmental constraints (no sit–stand desk), (e) weather and commuting barriers. Facilitators were identified by both studies as: (a) education about sedentary risk, (b) external cues (activity prompts, reminders), (c) self-monitoring (steps, sitting data), (d) physical environment supports (standing desks, stools), (e) leadership and organisational endorsement, (f) reframing productivity to include movement

Integrated Interpretation

Snacktivity works best when individual habit cues are reinforced by environmental and social permission. Without these, behaviour change is harder to sustain.

Refining the Initial Programme Theory

The current evidence can provide initial support and consideration for the IPTs that are proposed. The most directly supported IPTs were IPT2, IPT4, IPT5 when applied, most often from the demographics of middle aged white females. See Table 3 for a summary of the refined programme theories.

Table 3. A summary of support from initial evidence and refined IPTs to be tested further.

PT	Status	Rationale	Refined IPT
IPT1 (Snacktivity supports engagement in physical activity and improves outcomes by reducing perceived threat and fear)	**Partially supported → refine**	Supported indirectly via indications of improvements in pain, perception of the condition, mood, social functioning. This means it is possible that fear or threat is reduced but not explicit from current evidence.	Snacktivity supports engagement by lowering the perceived burden and risk of activity, increasing psychological safety and feasibility rather than eliminating fear directly.
IPT2 (Snacktivity enhances self-efficacy through repeated mastery experiences.)	**Strongly supported**	Strongly supported directly by habit outcome indicators and changes in sitting, sedentary time and light physical activity changes and supported by psychosocial confidence/esteem/perc/	Repeated, achievable Snacktivity bouts generate mastery experiences that enhance self-efficacy and confidence, supporting sustained engagement through habit formation rather than performance gains.

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		perception of living with the condition indicators.	
IPT3 (Pain/soreness minimisation)	**Supported → context-dependent**	Evidence supports this indirectly by identifying benefits on disability, pain interference, adherence. However, not pain elimination.	Brief, distributed activity reduces symptom exacerbation and functional interference, disrupting negative reinforcement cycles and enabling continued participation despite ongoing symptoms.
IPT4 (Education/coaching → meaning-making)	**Strongly supported**	Consistent combination of counselling based approached used and identification of emotional role functioning improvement, mood and energy change and confidence as well as life satisfaction indicators, combined with mechanism of education about sedentary risk, refarming productivity and social permission support this process theory.	Education and coaching components activate meaning-making and motivational mechanisms (e.g., reframing movement as legitimate, valuable, and achievable), increasing adherence and perceived value of activity.
IPT5 (Environment/routine → autonomy/habit)	**Strongly supported**	One of the clearest explanatory mechanisms is provided by this from qualitative evidence of factors which influence the program. This is supported by habit change identified in outcome domains and the direct benefits link to positive behaviour change.	Environments and routines that afford spontaneous movement provide cues, permission, and autonomy that support habit formation, amplifying intervention effectiveness.

Further Evaluation of the Programme Theory

To test PTs further, evidence was compared to other groups located by the initial search of studies located in the PRISMA diagram.

Search Output

Further evidence from different groups was used to support and develop the PTs. From the initial search output the below grouping of included studies was identified including; 12 qualitative studies (André and Lundberg, 2022; Boutevillain et al., 2017; Christensen et al., 2023; Cook and Hassenkamp, 2000; Cool et al., 2010; Curran et al., 2023; Gokal et al., 2023; Krouwel et al., 2023; Lainsing et al., 2021; Manaenkova and Santanna, 2025; Pronk et al., 2012; Tyldesley-Marshall et al., 2022), eight studies on older adults (Fyfe et al., 2022; Graham et al., 2025; Hu et al., 2026; Liang et al., 2023; Laing et al., 2024; Oppezzo et al., 2021; Perkin et al., 2019; Stawarz et al., 2023), eight studies

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where individual were identified as inactive (Babir et al., 2025; Daley et al., 2025; Jenkins et al., 1995;Krouwel et al., 2023; Mues et al., 2025; Thøgersen-Ntoumani et al., 2023; Tyldesley-Marshall et al., 2022; Yin et al., 2024), five studies on healthy individuals (Chandran et al., 2023; Foley et al., 2016; Gallaher et al., 2019; Sanders et al., 2023; Stork et al., 2024) and seventeen studies focusing on individuals with chronic illnesses (Babir et al., 2026; Cheng et al., 2021; Jakicic et al., 1995; Jansons et al., 2023; Lynch et al., 2019; Lynch et al., 2014; Maxwell-Smith et al., 2019; Norha et al., 2022; Norha et al., 2025; Patterson et al., 2023; Poppe et al., 2019; Sjoros et al., 2023; Sjoros et al., 2023; Thomsen et al., 2020; Thomsen et al., 2017; van Bakel et al., 2023; Western et al., 2023)

Demographics of Additional Samples

A total of 42 studies were represented in the additional group data. This included at total of 3064 (1439, women 1540, no gender information 94). The aggregate mean age across these studies was 54.6 years. Across the 18 studies on people with chronic illness (14 without duplicate information) there was a total of 1312 participants (428 women, 884 men). There was a total of 6 conditions identified, with cardiometabolic conditions (n=5) and cancer (n=4) being the most represented groups. Most studies were conducted in Australia (n=6). The majority of studies were community or home based (n=9). The aggregate mean age was 59.9 years. Across the eight qualitative studies a total of 1050 were included, this was represented by 351 men, 632 women, 67 gender not reported). The majority of the group was made up by one study of 724 individuals from the general public, after these 6 studies included individuals with low back pain and 2 included inactive individuals. The aggregate mean age was 45.3 years. Most studies were undertaken in the United Kingdom (n=5) followed by the USA (n=3) and China (n=2). Seven studies were home based, four were home and workplace, and 3 were primary care settings. Across the eight studies on older adults (n = 342, 103 men, 214 women, 25 gender not reported), participants were recruited from home-based and community settings across six countries (Australia, Ireland, China, UK, Taiwan, USA). The aggregate mean age was 71.2 years, with most studies focusing on adults in their early-to-mid seventies, including several cohorts described as pre-frail. Across the eight inactive group studies (n = 360, 101 men, 266 women, 2 not identified), there were two studies from the United Kingdom and Canada and one each from China, Australia and Germany. There were 6 community-based studies (3 within the workplace), and two laboratory studies. Most designs were randomised control trials (n=5) or qualitative duplicates (n=3). The aggregated mean age was 45.8 years.

Mapped Results

The above studies were mapped to the evidence for previous synthesis of results from the LBP studies. Table 4 provides a complete comparison of evidence against other conditions. This table provides evidence that psychosocial outcomes (confidence, mood, vitality) change more consistently than performance related outcomes and that habit formation is more often expressed as a substitution (e.g., standing more or moving more) rather than increased break frequency. Perceived feasibility and legitimacy of movement is more important than fear reduction. Objective sitting reduction is helpful but not required for engagement and behaviour change occurs even when pain, fatigue or disease symptoms persist. The information extracted suggests a shift from a dose-response exercise model where a focus is on specific intensities and accumulation of moderate or vigorous physical activity to a model that focuses initially on participation enablement and building changes in habits and confidence.

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Table 4. Evidence comparing outcomes from low back pain studies with evidence from other population groups.

Studies	Evidence for reduced sitting & light physical activity	Evidence for habit formation outcomes (standing more or breaking up prolonged sitting)	Quality of life Outcomes	Pain	Confidence	Mood and Energy or Fatigue
Chronic conditions	**Reduce sitting and sedentary behaviour** • 6/15 studies @Sig with OE (reductions between 42-51 mins/day) • 5/15 meaningful within group reductions • 3/15 no meaningful effect **Light physical activity** • 6/15 studies @Sig with OE • 5/15 studies no group effect but meaningful changes • 4/15 with no light physical activity change noticed	**Direct habit Indicators** • 5/15 studies identified significant changes (setting/standing) with 4/15 @Sig OE. • 10/15 with any habit relevant evidence • 2/15 with no evidence **Habit mechanisms** • 5/15 with supportive mechanisms • 3/15 with adherence driven evidence • 3/15 with cue-based intervention • 3/15 explicitly theory	• 4/15 (4/5) identify @Sig with SR • 3/15 used SF-36 to quantify with clinically meaningful change across both physical and mental sub-domains • 10/15 did not measure the domain	• 2/15 (2/6) identify @Sig with SR • 2/15 used VAS and identify clinically meaningful change • 2/15 identified no significant effect (although 1/15 identified association of reduced pain with decrease body mass index or body fat) • 1/15 reported worsening of COPD scores and or pain • 9/15 did not measure pain	• 8/15 with some sort of confidence signal (qualitative and quantitative combined) • 4/15 (4/8) @Sig SR. using validated scale. 3/15 with moderate and large effect • 4/15 identified qualitative evidence of improvement - mechanisms identified as exercises perceived as manageable, reduced apprehension of activity, feeling in control of progression, reduced psychological barriers • 7/15 did not measure confidence	**Mood** • 4/15 (4/9) @Sig SR • 2/15 with sustained effects • 3/15 with qualitative evidence • 1/15 with limited benefit • 6/15 did not report mood **Energy or Fatigue** • 3/15 (3/9) @Sig SR • 4/15 (4/9) reported positive energy or reduced fatigue evidence e.g., sit to stand repetition, tolerance for repeated movement, less tired during daily activities • 6/15 did not measure energy or fatigue
Older adults	**Reduce sitting and sedentary behaviour** • 2/8 studies @Sig with OE(reductions between 40-50 minutes) • 2/8 qualitative supporting evidence • 3/8 supportive but sitting measurement (e.g., sit to stand)	**Direct habit indicators** • 4/8 studies identifying significant change 1/8 with @Sig OE. **Habit mechanisms** • 7/8 with supportive mechanisms	• No studies reported quality of life outcomes	• 1/8 (1/1) provided qualitative evidence of reduced knee and hip stiffness, perceived reduction in joint discomfort	• 1/8 identified significant improvement within study • 5/8 identified qualitative evidence of improvements • Mechanisms included: exercise being	**Mood** • 3/8 (3/6) with @Sig SR • 2/8 with sustained effects • 1/8 with limited benefit • 4/8 with qualitative evidence of improved emotional

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	Light physical activity • 1/8 studies @Sig OE • 3/8 meaningful SR within group	• 5/8 evidence of adherence • 4/8 routine establishment • 4/8 environmental cues • 3/8 prompts • 4/8 intention to continue post intervention		• 7/8 did not measure pain	manageable and empowering, functional gains meant more confidence, improved safety or less threat, sense of achievement, actives that are achievable, improved capability of daily tasks	stability, better mood with exercise, better emotional regulation, • enjoyment following session • 2/8 did not report on mood **Energy or Fatigue** • Direct measurement not identified • 5/8 identified support from indirect measures e.g., sit to stand improvements or step count
Inactive adults	**Reduce sitting and sedentary behaviour** • 4/8 of SR evidence • 1/8 no between group difference **Light physical activity** • 1/8 studies @Sig OE • 4/8 SR meaningful within group evidence	**Direct habit indicators** • 5/8 studies with positive/supportive change from SR. • 5/8 of explicit sitting to movement substitution from SR • 3/8 supportive evidence around automaticity from SR **Habit formation mechanisms** • 7/8 with supportive mechanism identified • 6/8 adherence • 5/8 routine scheduling • 5/8 behavioural substitution • 4/8 prompts or	• No studies reported quality of life outcomes	• 2/8 (2/2) pain discussed as a barrier • 6/8 did not measure pain	• 1/8 (1/1) provided qualitative evidence • 4/8 (4/7) identified qualitative evidence of improvements • Mechanisms identified: reduce fear of injury, physical activity now considered achievable, improved perception of capability, snack are easy and flexible, change in understanding of what counts as exercise, ability to adhere to a high level, ease of integrating movement into routines, repeated use of familiar environment	**Mood** • 1/8 (1/4) @Sig SR • 3/8 identified qualitative improvements around feeling well, improved mood and feeling better because of intervention or just after • 4/8 did not measure **Energy or Fatigue** • 2/8 indirect @Sig SR • 5/8 qualitative reports of positive energy and less fatigue during tasks and when exercising and more energy after exercise

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		technology reminders • 4/8 environmental or contextual cues • 4/8 low effort burden • 3/8 intension to continue		• 1/8 did not measure	
Healthy adults	**Reduce sitting and sedentary behaviour** • 3/8 positive significant evidence (2/8 @Sig with OE) **Light physical activity** • 2/5 with between group evidence (1/5 with OE @Sig) • 2/5 SR meaningful within group change	**Direct habit indicators** • 1/5 with @Sig OE **Habit formation mechanism** • 4/5 with supportive mechanism identified • 3/5 prompts or technology reminders • 3/5 behavioural substitution • 2/5 environmental restructuring • 2/5 anchoring routines and context • 2/5 self-monitoring or feedback	• No studies reported quality of life outcomes	• 1/5 (1/2) with @Sig SR • 1/5 identified @Sig OE • 3/5 did not measure pain	• 1/5 @Sig SR. • 1/5 improvements in SR • 1/5 with mechanisms identifying better awareness and knowledge and attitudes towards physical activity • 2/5 did not measure confidence	**Mood** • 2/5 @Sig SR • 1/5 identified @Sig preservation of cognitive stage • 2/5 did not measure mood **Energy or Fatigue** • 3/5 @Sig SR via indirect measure e.g., improvement in RPE during exercise • 1/5 reduced discomfort • 1/5 did not measure fatigue

Based on this evidence, a final refinement of each PT was performed; see Table 5 for context mechanism and outcome information, together with embedded qualitative illustrations from qualitative evidence.

Table 5. CMO configurations for final PTs.

PT	Context	Mechanism	Outcome
1	• Adults with chronic pain expect movement to cause harm or symptom flare • Past exercise attempts associated with failure, pain exacerbation, or uncertainty • Social and workplace norms discourage standing or visible movement	• Reduced perceived burden (“this is small”, “manageable”) • Reduced perceived threat (“this won’t make things worse”) • Increased psychological safety (movement framed as optional, brief, self-paced, legitimate)	• Willingness to initiate movement • Sustained participation despite pain • Engagement without requiring fear extinction
	Illustrative evidence:		

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		• "I can't really trust the body." *(Andre & Lundberg, 2022)* "I try to be careful… I'm afraid it's going to get worse." *(Andre & Lundberg, 2022)* • "It feels socially unacceptable to stand up when everyone else is sitting." *(Lansing et al., 2021)* "Since we did it with the physiotherapist, you still feel that then it's probably okay." *(Andre & Lundberg, 2022)*	
2	• Low baseline self-efficacy • History of unsuccessful or overly demanding exercise • Limited confidence in bodily capability	• Mastery experiences from completion, not performance • Positive feedback loop: completion → confidence → repetition • Identity shift ("I am someone who moves") **Illustrative evidence:** • "You don't realise how inactive you are… until you start seeing the numbers." (Lansing et al., 2021) • "Seeing how much Snacktivity™ has been completed throughout the day." (Gokal et al., 2022) • "It has almost become my routine which is really positive." (Krouwel et al., 2023)	• Increased self-efficacy • Habit formation through repetition • Sustained engagement independent of fitness change
3	• Chronic pain linked to avoidance, deconditioning, and symptom worsening • Boom–bust cycles common • Fatigue and limited daily energy	• Short bouts avoid symptom flare • Distributed activity prevents post-exertional worsening • Positive bodily feedback interrupts avoidance–symptom loop **Illustrative evidence**: • "Any minimal physical activity… is torture." (Boutevillain et al., 2017) • "Because of my pain, I have less energy than a normal person." (Christensen et al., 2023) • "I'm not in pain when I'm sitting down… so I tend to sit a lot." (Curran et al., 2024)	• Reduced symptom interference • Greater consistency of movement • Increased energy and vitality
4	• • Dominant cultural narrative: "exercise must be hard to matter" • Small actions are discounted or trivialised • Lack of validation for movement in pain	• Cognitive reappraisal ("this is worthwhile") • Increased perceived value of movement • Internalisation of movement identity **Illustrative evidence:**	• Improved adherence • Greater engagement • Increased perceived benefit even before physical change

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		• "Now I know I think it might help [to move]." (Andre & Lundberg, 2022) • "It makes me feel like I'm doing something good for myself." (Christensen et al., 2023) • "It's helping me refocus." (Lansing et al., 2021)	
5	• • Busy lives and fluctuating symptoms • Limited cognitive bandwidth • Work and home environments that default to sitting	• Environmental cues reduce decision load • Permission to move replaces obligation Automaticity develops through context-linked repetition **Illustrative evidence:** • "The Fitbit… buzzed… to say get up and move." *(Lansing et al., 2021)* • "The reminders at the time are what works for me." *(Krouwel et al., 2023)* • "I actually was able to get a standing desk." *(Lansing et al., 2021)*	• Habitual movement • Sustained behaviour with low effort • Reduced reliance on motivation

Final PTs

PT1 shows confidence improves without fear being explicitly targeted and whilst pain could remain present, adherence is still high. Qualitative evidence suggest that it is because it is doable. The refined program theory is:

Final PT1: Snacktivity works not by changing fear beliefs, but by bypassing them through low-threat action.

PT2 has good evidence around the value and impact of confidence resulted from Snacktivity interventions and that low self-efficacy is a primary context needed to change for improvement.

Final PT2: *Mastery arises from successful repetition of achievable actions, not from improvement in strength, fitness, or pain.*

PT3 has support from evidence around meaningful pain reduction and fatigue improvement as well as improved tolerance and vitality, people feeling less stiff, having more energy, and perceiving better days are identified.

Final PT3: *Snacktivity works by interrupting negative reinforcement cycles, not by removing symptoms.*

PT4 identified that education can help reframe movement as legitimate and not trivial. Coaching helps validate that shout bouts count and movement is valuable even without fitness gains and finally that mood improves alongside reframing through support.

Final PT4: *Education works not by increasing information, but by changing what movement means.*

PT5 identifies the importance of habit relevant evidence and identifies the cues, prompts, routines aid consistence and adherence. When movement is embedded in daily context and when wen no scheduling or preparation if required habit formation is possible.

Final PT5: *Snacktivity succeeds when environments make movement easy, not when people are motivated to plan it.*

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Discussion

This realist review sought to explain how, why, and for whom Snacktivity-type interventions support engagement in physical activity among adults with chronic low back pain, rather than focusing solely on effectiveness. The synthesis indicates that Snacktivity operates primarily as a participation-enabling intervention, with psychosocial and contextual mechanisms consistently explaining engagement and sustained behaviour change, even when pain, fatigue, or symptoms persist (Barone Gibbs et al., 2018; Ellingson et al., 2026; Lansing et al., 2021).

Across studies, engagement was maintained without explicit fear reduction, supporting the refinement of PT1. Rather than eliminating fear, Snacktivity appears to lower perceived burden and threat, increasing psychological safety and feasibility (Fyfe et al., 2022; Krouwel et al., 2023; Tyldesley-Marshall et al., 2022). This aligns with contemporary pain literature suggesting that avoidance is more effectively addressed through safe action and feasibility than cognitive challenge alone (Vlaeyen & Linton, 2012; George et al., 2022).

The strongest and most consistent evidence supported PT2 and PT5. Repeated, achievable activity bouts generated mastery experiences, enhancing self-efficacy and confidence independently of performance gains (Ellingson et al., 2026; Thomsen et al., 2017; Bandura, 1997). Habit formation was most commonly expressed as behavioural substitution (standing or moving more) rather than increased activity volume, particularly when cues, routines, and environmental affordances were present (Lansing et al., 2021; Gardner et al., 2012; Jones et al., 2024). These findings reinforce that habit formation, not fitness change, is a central mechanism of Snacktivity.

Evidence also supported PT3, though in a context-dependent manner. Snacktivity did not consistently eliminate pain; instead, brief and distributed activity appeared to reduce symptom interference, fatigue, and post-exertional exacerbation, disrupting negative reinforcement cycles that typically drive avoidance (Thomsen et al., 2017; Norha et al., 2025; Comachio et al., 2025). Improvements in vitality and fatigue were among the most consistent health-related outcomes across chronic pain and comorbid populations, even when objective physical activity change was modest (Hergenroeder et al., 2022; Sjöros et al., 2023).

Finally, PT4 was strongly supported. Education and coaching components did not simply increase knowledge but reframed movement as legitimate, valuable, and achievable, enhancing meaning-making and perceived benefit (Amorim et al., 2019; Keefe et al., 2018; Ho et al., 2022). Improvements in mood, emotional role functioning, confidence, and life satisfaction occurred alongside this reframing, suggesting that psychosocial change precedes and sustains behavioural change (Hergenroeder et al., 2022; Ellingson et al., 2026).

Overall, this review suggests a shift away from a dose–response exercise model toward a participation enablement model, in which Snacktivity supports sustained engagement through psychological safety, mastery, habit formation, and contextual fit. These mechanisms appear particularly well-suited to chronic low back pain, where fluctuating symptoms, fear, and fatigue commonly undermine traditional exercise approaches (Hartvigsen et al., 2018; Wood et al., 2024).

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