RESEARCH ARTICLE

EFFECT OF SMARTPHONE-DELIVERED MICRO-BREAK EXERCISES VERSUS CONVENTIONAL ERGONOMIC ADVICE ON PERCEIVED FOREARM FATIGUE AND PAIN IN FOOD DELIVERY RIDERS: A RANDOMIZED CONTROLLED TRIAL

Bhavithra Devi Selvaraju[1*], Pratik Chettri[2], Manisha[3], Aakriti Jain[4], Kirandeep Kaur[5], Indraneel Mohan Shejwadkar[6], Navita Sharma[7], Hansa Chaudhary[8], Jayalakshmi P. T.[9], Mehnaz Fatima Abdul Nasir[10], Probhjot Singh Nalwa[11]

[1]Senior Assistant Professor, JSS College of Physiotherapy, Ramachandra Agrahara, Mysuru, Karnataka – 570004, India. ORCID: 0009-0000-9490-0939

[2]Associate Professor, Sikkim Manipal College of Allied and Healthcare Professions, Sikkim – 737102, India. ORCID: 0000-0003-0694-6406

[3]Assistant Professor, Department of Physiotherapy, School of Allied and Healthcare Sciences, GNA University, Phagwara, Punjab, India. ORCID: 0009-0000-2916-3784

[4]Assistant Professor, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India. ORCID: 0009-0003-7302-9664

[5]Assistant Professor, Musculoskeletal Physiotherapy, Department of Physiotherapy, CGC University, Mohali, Punjab – 140307, India. ORCID: 0009-0004-4842-9313

[6]Associate Professor, AIMS College of Physiotherapy, Maharashtra – 421204, India. ORCID: 0000-0002-6395-5504

[7]Assistant Professor, Department of Physiotherapy, School of Allied Health Sciences, Galgotias University, Uttar Pradesh – 203201, India. ORCID: 0000-0002-0592-5577

[8]Assistant Professor, Department of Physiotherapy, IIMT University, Meerut, Uttar Pradesh – 250001, India. ORCID: 0009-0003-8870-2639

[9]Assistant Professor, Department of Physiotherapy (Allied Health Sciences), IIMT University, Meerut, Uttar Pradesh – 250001, India. ORCID: 0009-0003-5373-071X

[10]Tutor/Clinical Demonstrator, MGM School of Physiotherapy, Kamothe, Navi Mumbai, Maharashtra, India. ORCID: 0009-0000-3144-5449

[11]Assistant Professor, CGC University, Mohali, Punjab – 140307, India. ORCID: 0009-0005-0208-963X

***Corresponding Author:** Bhavithra Devi Selvaraju

Email: bhavithraruders.devi2@gmail.com

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ABSTRACT

Background: Food delivery riders make constant, repeated use of the forearms on the handlebars, throttle and brake, and this continuous load on the forearm can cause musculoskeletal symptoms. Food delivery riders often lack access to occupational health programmes to manage their symptoms, and it is unclear whether conventional ergonomic advice or frequent break reminders delivered through the phone they already use will help to alleviate these symptoms.

Objective: To assess the effect of 8 weeks of break reminders in the form of micro-break exercises delivered through the phone, compared with conventional ergonomic advice, on forearm pain and perceived forearm fatigue in food delivery riders.

Methods: This was a parallel-group randomized controlled trial with assessors blinded to group allocation. A total of 160 active riders with forearm discomfort were randomized 1:1 to one of two groups. Group 1, the micro-break group, used a smartphone application that prompted a 2-minute forearm exercise break every 60–90 minutes, to be taken only when the rider had safely stopped. Group 2, the control group, received one session of ergonomic education and an educational handout. The primary outcome was the change in worst forearm pain from baseline to Week 8 on the Numeric Pain Rating Scale (NPRS, 0–10), with assessments at baseline, Week 4 and Week 8. Secondary outcomes were perceived forearm fatigue (Borg CR-10) and upper-limb disability (QuickDASH). Riders who completed follow-up were analysed, and the micro-break group was compared with the control group for all outcome measures.

Results: Of the 160 randomized participants (80 per group), 144 (90.0%) completed the Week 8 assessment. At Week 8, the mean reduction in pain was 2.45 ± 1.61 points in the micro-break group and 1.27 ± 1.59 points in the control group

($p<0.001$). The groups did not differ at Week 4 (1.13 ± 1.66 and 1.01 ± 1.67 points, respectively; $p=0.60$). The mean reduction in perceived forearm fatigue at Week 8 was 2.25 points in the micro-break group and 0.66 points in the control group ($p<0.001$), and the between-group difference in QuickDASH change was −7.2 points (95% CI −10.2 to −4.1) in favour of the micro-break group.

Conclusion: Compared with a single session of ergonomic advice, an 8-week micro-break programme reduced forearm pain and perceived forearm fatigue more in food delivery riders. The mean decrease in pain in the micro-break group was 2.45 points, which meets the approximately 2-point decrease considered clinically relevant, whereas the decrease in the control group was 1.27 points. Longer follow-up is warranted.

Keywords: Food delivery workers, Gig economy, Forearm pain, Perceived fatigue, Mobile health, Micro-break, Occupational musculoskeletal disorders.

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INTRODUCTION

The delivery industry has grown significantly in recent years, particularly with the introduction of app-based food delivery services, and with this growth has come an increase in the worldwide, largely informal workforce. Understanding the physical demands of these jobs is important to provide proper protection and support for delivery workers. Riders use their arms and hands to control the motorcycle while also handling navigation, orders and payment on their phones, and these activities can contribute to localised muscle fatigue and discomfort. In cyclists, vibration transmitted through the handlebar increased forearm muscle activity, suggesting that handlebar users may be at risk of overuse problems.[1]

A survey of food delivery workers in Shanghai found that 54.9% of participants reported musculoskeletal symptoms, and that longer employment and a greater daily delivery distance were associated with more severe symptoms; however, the body locations of these symptoms were not described.[2] Food delivery workers generally do not have access to rest breaks or support to protect them from the demands of their work, so prevention strategies have largely been educational. Although workplace preventive strategies are recommended, the demands of delivering food and drink mean that such strategies are often ineffective and depend on the memory and commitment of the workers.

Breaks interspersed throughout the day, especially those that include short bouts of physical activity, may be an effective means of preventing fatigue and pain. A narrative review of 15 randomized trials found that these micro-breaks, when active (that is, including physical activity such as stretching or strengthening), reduced fatigue and pain more than breaks without any activity.[3] The evidence is not consistent, however: a Cochrane review found that work-break schedules may not substantially reduce the occurrence of musculoskeletal disorders,[4] and reviews of workplace interventions for upper-limb disorders found stronger evidence for resistance training than for stretching.[5] The main barriers to workplace interventions, lack of time and funding, may be of less concern for interventions delivered through a smartphone. In one trial, participants who received a 12-week artificial intelligence-assisted programme of exercise prompts through a smartphone messaging application reported less neck and shoulder pain and stiffness, as well as less low back pain, than the control group.[6] Food delivery workers are a relevant target population because of the nature of their work and the absence of studies of activity-prompting and work-break programmes in this population.

The objective of this study was therefore to compare an activity-prompting programme of micro-break exercises with conventional ergonomic advice for reducing forearm pain and forearm fatigue in food delivery workers.

Aim and Objectives

The aim of this study was to assess a smartphone-delivered exercise programme to relieve forearm pain and reduce perceived fatigue in food delivery riders, and to compare this programme with conventional ergonomic advice. The specific objectives were to compare the change in worst forearm pain between the study groups after 8 weeks, to assess perceived forearm fatigue and to compare upper-limb function and disability between the groups.

MATERIALS AND METHODS

Study Design

This was a single-blind randomized controlled trial with two parallel groups and 1:1 allocation, assessing the efficacy of the micro-break programme compared with usual care (advice). Written informed consent was obtained from all participants. The study is reported according to the CONSORT 2010 statement and its extension for non-pharmacologic interventions,[7] and the micro-break programme is described using the TIDieR checklist and guide.[8]

Participants

Study participants were food delivery riders working for different delivery platforms in the Greater Accra region. Participants were recruited at delivery hubs and rider gathering points and through community outreach. Potentially eligible riders were invited for an in-person screening if they were aged 18–55 years; had worked as a food delivery rider on a motorcycle or scooter for a minimum of 6 months and an average of at least 5 days a week; had experienced forearm and/or wrist pain or discomfort in the last 3 months, with a worst pain score of

at least 3/10 in the last 7 days; owned a smartphone able to run the study application; and provided written informed consent. Riders were ineligible if they had had an upper-limb fracture or surgery in the last 6 months; had cervical radiculopathy, inflammatory arthritis, diabetic neuropathy or a neurological disease; were receiving an upper-limb corticosteroid injection or physiotherapy; or were pregnant. Riders who could not fully understand and participate in the study in the local language were also excluded.

Randomization and Blinding

A statistician randomized participants using a computer-generated sequence in blocks of 4 and 6, stratified by weekly working hours (<50 vs ≥50). Allocations were concealed in sequentially numbered, opaque, sealed envelopes, which a coordinator kept until the baseline assessment. Participants were not blinded to their allocation. Outcome assessors and the statistician performing the main analysis did not know group allocations, and participants were asked not to disclose their group to assessors.

Interventions

Micro-break group: Participants downloaded and were familiarised with a study smartphone application. During work hours, the application produced an auditory and vibrating alert every 60–90 minutes, with up to six alerts per work day; the interval between alerts was randomized to prevent habituation. The alerts reminded participants to take a break from work, and the application reminded them to pull over to a safe location and displayed an additional safety reminder. Each micro-break took about 2 minutes and comprised (1) wrist flexor and extensor stretches (20 seconds each side); (2) finger and thumb tendon-gliding movements (30 seconds); (3) active grip release, opening the fingers against resistance from the other hand (30 seconds); and (4) forearm shaking and gentle self-massage (20 seconds). No equipment was needed. Participants could snooze a prompt for 10 minutes or skip it. Participants in this group were also given the same written ergonomic advice as the control group.

Control group (conventional ergonomic advice): Participants received a 20-minute face-to-face education session with a physiotherapist and an illustrated education leaflet. They were taught the importance of keeping the wrist in a neutral position and how to adjust the handlebar, levers and phone in relation to the wrist and grip, and were advised to take regular breaks. The control group received no prompts and was asked not to use any other exercise or activity applications. Both groups were offered the other intervention after their final follow-up.

Outcome Measures

Assessments were conducted at the study centre at baseline (Week 0) and at Weeks 4 and 8. The primary outcome was the change in worst forearm pain over the previous 7 days from baseline to Week 8, assessed in the throttle (dominant) arm using the 11-point Numeric Pain Rating Scale (NPRS; 0 = no pain, 10 = worst imaginable pain). NPRS scores are reported as means and standard deviations (SDs).

Secondary outcomes were (i) perceived forearm fatigue, rated by the participant for the forearm at the end of a typical work shift in the previous 7 days on the Borg CR-10 scale;[9] and (ii) upper-limb function and disability, assessed with the QuickDASH questionnaire.[10] Both were assessed at Weeks 0, 4 and 8, so no additional contact with participants was required.

Sample Size

The sample size was calculated for the primary outcome, assuming a between-group difference of 1 point on the NPRS, which is smaller than the approximately 2-point (30%) change considered clinically important in chronic pain,[11] and a standard deviation of 2 points. With a two-sided α of 0.05 and 80% power, 63 participants were required per group; allowing for 20% dropout, 80 per group (160 in total) were enrolled.

Statistical Analysis

Complete-case analysis was performed on riders who completed the assessment at each time point. Data are reported as mean ± SD or n (%). Change from baseline at Week 4 and Week 8 is reported as mean ± SD. For the NPRS and Borg CR-10, change was calculated as the baseline score minus the follow-up score, so larger values indicate greater improvement; for QuickDASH, change was the follow-up score minus the baseline score, so more negative values indicate greater improvement. Because QuickDASH is continuous, its change from baseline was compared between groups using the independent samples t-test, and the mean difference with its 95% confidence interval (CI) is reported at Week 8. Changes in NPRS and Borg CR-10 scores were compared using the Mann–Whitney U test. Secondary outcomes were analysed as exploratory, and no adjustment was made for multiple comparisons. Statistical significance was set a priori at $\alpha = 0.05$ (two-tailed).

RESULTS

Of the 160 randomized riders (80 micro-break and 80 control), 77 (96.3%) micro-break and 75 (93.8%) control participants provided follow-up data at Week 4, and 73 (91.3%) and 71 (88.8%), respectively, at Week 8. In the micro-break group, Week 8 data were missing for 7 participants because of illness unrelated to the study (n=5) or withdrawal for lack of time (n=2). In the control group, data were missing for 9 participants because of withdrawal for lack of time (n=4), loss to follow-up (n=2), relocation (n=1), unrelated illness (n=1) or leaving delivery work (n=1). The groups were similar at baseline (Table 1), although the micro-break group included a higher proportion of men (96.3% vs 90.0%) and had a higher mean age (33.9 vs 31.3 years) and BMI (24.9 vs 23.8 kg/m²) than the control group.

Table 1: Baseline demographic and work characteristics of participants

Variable	Micro-break group (n=80)	Control group (n=80)
Age (years), mean ± SD	33.9 ± 8.0	31.3 ± 8.1
Male, n (%)	77 (96.3)	72 (90.0)
BMI (kg/m²), mean ± SD	24.9 ± 3.4	23.8 ± 3.4
Years as rider, mean ± SD	3.9 ± 3.0	3.9 ± 2.5
Working hours/week, mean ± SD	51.5 ± 8.4	51.3 ± 7.9
Deliveries/day, mean ± SD	23.9 ± 7.6	21.9 ± 6.7

Variable	Micro-break group (n=80)	Control group (n=80)
Baseline worst forearm pain (NPRS), mean ± SD	5.3 ± 1.4	5.5 ± 1.3
QuickDASH score, mean ± SD	26.0 ± 8.4	25.2 ± 7.8
Baseline perceived forearm fatigue (Borg CR-10), mean ± SD	4.8 ± 1.2	4.4 ± 1.2

BMI: body mass index; NPRS: Numeric Pain Rating Scale; SD: standard deviation.

Primary Outcome: Forearm Pain (NPRS)

In the micro-break group, the mean reduction in worst forearm pain was 1.13 ± 1.66 points at Week 4 and 2.45 ± 1.61 points at Week 8. In the control group, it was 1.01 ± 1.67 points at Week 4 and 1.27 ± 1.59 points at Week 8. The groups did not differ at Week 4 (U=3029.0; p=0.60), but at Week 8 the reduction in pain was significantly greater in the micro-break group (U=3675.5; p<0.001) (Table 2). The reduction in the micro-break group reached the clinically important 2-point change at Week 8,[11] whereas the reduction in the control group did not.

Table 2: Comparison of primary and secondary outcomes between groups

Outcome	Group	Week 4	Week 8
NPRS reduction (pain)	Micro-break	1.13 ± 1.66	2.45 ± 1.61
	Control	1.01 ± 1.67	1.27 ± 1.59
	p value (test)	0.60 (U = 3029.0)	<0.001 (U = 3675.5)
Borg CR-10 reduction (fatigue)	Micro-break	1.21 ± 1.51	2.25 ± 1.53
	Control	0.62 ± 1.37	0.66 ± 1.46
	p value (test)	0.006 (U = 3624.0)	<0.001 (U = 4098.5)
QuickDASH change (disability)	Micro-break	−5.8 ± 9.5	−11.8 ± 9.7
	Control	−4.6 ± 8.3	−4.6 ± 8.8
	p value (test)	0.40 (t = −0.84)	<0.001 (t = −4.65)

Values are mean ± SD change from baseline. Riders analysed: Week 4, 77 micro-break and 75 control; Week 8, 73 and 71. U: Mann–Whitney U; t: independent-samples t. Larger reductions in NPRS and Borg CR-10 and a more negative QuickDASH change indicate greater improvement.

Secondary Outcomes

Perceived forearm fatigue (Borg CR-10): In the micro-break group, the mean reduction in perceived fatigue was 1.21 ± 1.51 points at Week 4 and 2.25 ± 1.53 points at Week 8; in the control group, it was 0.62 ± 1.37 and 0.66 ± 1.46 points, respectively. The reduction was greater in the micro-break group at both Week 4 (U=3624.0, p=0.006) and Week 8 (U=4098.5, p<0.001).

Upper-limb disability (QuickDASH): In the micro-break group, scores decreased by 5.8 points at Week 4 and 11.8 points at Week 8; in the control group, they decreased by 4.6 points at both Week 4 and Week 8. The groups did not differ significantly at Week 4 (t=−0.84, p=0.40), but at Week 8 the decrease was significantly greater in the micro-break group (mean difference −7.2, 95% CI −10.2 to −4.1; t=−4.65, p<0.001). Secondary analyses were exploratory and not adjusted for multiplicity.

DISCUSSION

In this study, an 8-week forearm micro-break programme, prompted through a smartphone application, produced greater benefits at Week 8 than standard ergonomic advice. The mean reduction in pain was 2.45 points in the micro-break group and 1.27 points in the control group; the micro-break group crossed the threshold for a clinically important difference,[11] whereas the control group did not. At Week 8, the reduction in perceived forearm fatigue was also greater in the micro-break group. To the best of our knowledge, this is the first randomized trial of an application-prompted forearm micro-break programme in food delivery workers.

Studies in other occupations provide a comparable framework for this intervention. A review of 15 randomized trials found that active micro-breaks alleviated pain and fatigue more than passive breaks.[3] Andersen et al. showed that even 2 minutes of daily progressive resistance training produced clinically relevant reductions in neck and shoulder pain.[12] In sedentary work characterised by prolonged sitting, breaking up sitting time with brief bouts of standing and stretching relieved discomfort and fatigue more than passive breaks,[13] and in symptomatic computer operators, short active rest breaks reduced neck and shoulder discomfort, with no clear difference in muscle fatigue between break types.[14] Digital prompts may also be effective: daily exercise prompts sent via a messaging application to workers improved neck and shoulder pain and stiffness, as well as low back pain.[6] On the other hand, a Cochrane review concluded that break schedules alone may not substantially reduce the occurrence of musculoskeletal disorders,[4] and upper-limb reviews have found stronger support for resistance training than for stretching.[5] Unlike these interventions, our programme combined stretching, tendon gliding and active grip release, which may account for the reduction in pain and fatigue. Our results point in the same direction as studies of active breaks and exercise prompts, but those studies were mostly conducted in office, industrial and healthcare workers with different comparison groups and outcome measures, so the size of the effects cannot be directly compared. The control group also improved (mean reduction of 1.27 points), which is likely due to the education provided, natural fluctuation in symptoms or regression to the mean.

Taking a break from a sustained tight grip may help restore blood flow to the forearm by relaxing constantly active motor units. Because road and handlebar vibration increases forearm muscle activity,[1] taking a break from vibration-loaded gripping may also help explain the reduction in perceived forearm fatigue. However, perceived forearm fatigue may be reduced for other reasons, and the self-reported reduction does not confirm changes in motor units or blood flow, which were not measured.

This study has several strengths. It included members of a hard-to-reach target population, used concealed allocation and blinded assessment to reduce bias, and had an active control group reflecting current practice. It also has limitations. Participants could not be blinded, and pain and fatigue were self-reported and may have been influenced by other factors. The control group had less contact than the intervention group, so the effects may partly reflect responding to the prompts rather than the exercises themselves. Follow-up was short (8 weeks), fatigue ratings relied on recall of a typical shift in the previous week, and the findings may not be generalisable to other regions. Only participants with complete data at each time point were

analysed. In practice, the programme requires no equipment, takes about 2 minutes per break and could be offered through a delivery application, giving it the potential to improve the occupational health of gig economy workers. Its safety features require participants to confirm that the vehicle is not in motion, and any future implementation should retain them and monitor road incidents. Future modifications could include timing prompts automatically to when the vehicle comes to a complete stop, and future research could include cluster randomized controlled trials run through delivery platforms.

CONCLUSION

For food delivery workers with forearm discomfort, completing an 8-week micro-break programme in addition to receiving ergonomic advice produced greater reductions in forearm pain and perceived forearm fatigue than ergonomic advice alone. Further studies are warranted to examine the long-term impact of the micro-break programme.

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