Feasibility of a co-produced primary school-based intervention to improve children's motor competence and mental health and wellbeing (shortened title: Motor competence and mental health)

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Applicants
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Scientific abstract
Children's mental health has been negatively affected during the COVID-19 lockdown restrictions. According to the Elaborated Environmental Stress Hypothesis, anxiety and depression in children are associated with poor motor competence, and these associations may be mediated by social support and self-perceptions. Improving children's motor competence may therefore be a mechanism for promoting mental health through psychosocial factors. There is some evidence that schools are effective settings to improve mental health outcomes through motor skill interventions. Thus, we aim to co-produce and evaluate the feasibility of a school-based motor competence and mental health intervention. Six primary schools (four intervention, two control) from low socioeconomic status locations will be recruited. Child, teacher, school leader, and physical activity deliverer stakeholder groups will take part in an intervention co-production process to develop a 12-week motor competence and mental health intervention. Focus groups, interviews, observations, questionnaires, and motor competence assessments will be used to gather data on the feasibility and acceptability of the intervention to determine whether it should be subsequently developed into a pilot cluster RCT. Pre-post intervention changes in motor competence and mental health and the influence of psychosocial factors will also be explored.

Lay summary
Children's motor skill ability is linked to mental health problems such as anxiety and depression. The COVID-19 lockdown restrictions have negatively affected children's mental health and reduced their participation in physical activity, which is vital for motor skill development. As school-based programmes are promising ways to tackle declines in motor skills and mental health, we will work with children, teachers, school leaders, and physical activity specialists to develop a primary school intervention to improve children's motor skills and mental health. We will use different research methods to see how feasible and acceptable the intervention and our research approaches are. We will also measure the children's motor skills and mental health to see whether these change during the intervention, and how they relate to other factors like physical activity, and support from others. We will share our findings with children, teachers, physical activity providers, public health officials, and the academic community.

Theoretical and scientific rationale
The COVID-19 pandemic social distancing measures have resulted in unprecedented, enforced changes to people's routines and lifestyles. Children have been particularly affected, through school closures and online home learning, the ceasing of organised sports, and restrictions on

face-to-face social interactions. There is evidence that lockdown restrictions have negatively affected children's mental health and wellbeing (1), with those from lower socioeconomic status families disproportionately affected (2, 3). Furthermore, lockdown restrictions have driven increases in digital screen use and decreases in physical activity, and particularly structured activities (e.g., physical education lessons, sport participation (4, 5)), which are essential for development of motor competence (6) (i.e., the degree to which a child performs goal-directed movements in a coordinated, accurate, and relatively error-free manner (7)). Thus, reduced physical activity during the pandemic is likely to be reflected by attenuation of motor competence or slowing of motor competence development (8). Poor motor competence is associated with inhibited psychosocial development, including internalising problems such as anxiety and depression (9); these associations may be mediated by limited social support mechanisms (9, 10) and low self-perceptions (11, 12). Improving children's motor competence may therefore be a mechanism for promoting children's mental health through enhancing aspects of psychosocial development.

The inter-relationships between children's motor competence, mental health, and their mediators are described in the Elaborated Environmental Stress Hypothesis (EESH) (13). Empirical support exists for the EESH (14), which posits that poor motor competence predisposes children to internalising mental health problems (e.g., depression, anxiety) via interactions with environmental stressors such as low self-esteem, low social support, physical inactivity, overweight, etc. These stressors can in turn be 'buffered' by social and personal resources such as parental support and perceived competence (14). Previous studies in community samples have reported negative associations between motor competence, internalising problems and other psychosocial outcomes described in the EESH (10, 15). This proposal will be conceptually underpinned by the EESH and the 'buffering' components will be targeted as underlying characteristics of a proposed intervention.

In 2018 applicants SF and RT were awarded TWF grant #1669-3509. They found that low levels of motor competence were prevalent in 33% of the sampled 9-10 year old children. Compared to peers with superior motor competence, these less skilled children had more internalising mental health problems, poorer academic performance, and unfavourable physical activity levels (manuscript in review). These data and published evidence highlight a need for intervention strategies in primary school children to address the established low levels of motor competence and mental health and wellbeing which have declined further as a consequence of the COVID-19 lockdown measures (1, 8). Schools are suitable settings for the promotion of child health and wellbeing (16). Furthermore, primary school motor competence interventions can be efficacious for improving motor skills (17, 18) and there is some limited evidence that they can also enhance mental health and wellbeing (19, 20). However, no such studies involving mainstream school children without movement difficulties have been undertaken in the UK.

School stakeholders are more likely to 'buy-in' to interventions that are co-produced with children and teachers, and that align to statutory Personal, Social, Health and Economic Education curriculum guidance (21, 22). Co-production provides opportunities to participate in intervention development processes (23), thereby ensuring that the specific needs of stakeholders are targeted. The shared stakeholder ownership of the process provides a context-sensitive basis for an acceptable intervention with increased likelihood of it being effectively implemented and resulting in positive outcomes (21). Therefore, working with children, teachers, school leaders, and physical activity deliverers our aim is to co-produce and evaluate

the feasibility of a primary school intervention to improve children's motor competence and mental health and wellbeing.

Practical impact of the project
Please see section 'Expected impact of the project' on p. 6.

Research design
Participants would be Year 4 and Year 5 (age 8-10 years) children from one or two-form entry mainstream primary schools in West Lancashire who are physically able to participate in PE lessons. Schools will be located in low socioeconomic status (SES) areas based on school postcode-linked Indices of Multiple Deprivation (IMD; deciles 1-3)) (24) and >18% free-school meal (FSM) eligibility. Schools meeting these criteria and with at least 25 pupils per class, will be approached in the order produced by a random number generator until six agree to participate. After this they will be randomised to the intervention (4 schools) or usual practice control arms (2 schools). Using progression criteria Red/Stop upper limit and Green/Go lower limit reference tables provided by Lewis et al. (25) we estimated an intervention group sample size for child recruitment. Assuming an alpha level of 0.05 and 90% power to reject being in the Red zone if the Green zone holds true, the minimum required sample size is n=46. We propose to recruit up to 200 children to the intervention group (and 50 to the control group), which is significantly more than the estimates from the power calculation, and than the larger end of the sample size scale (n=100) typically observed in health behavioural pilot and feasibility studies (26). This will ensure a representative range of responses to the measures and engagement in the feasibility intervention. Thus, we believe that the planned sample size is sufficient to meet the study aim. Our recruitment strategy will include school and child participation incentives (e.g., vouchers).

Intervention co-production. Intervention co-production will involve children, teachers, school leaders, and physical activity deliverers from West Lancashire Sport Partnership (WLSP). These stakeholders will work in single and multiple stakeholder groups through a 6-stage process facilitated by the researchers. These stages align to the Double Diamond Design Approach (DDDA) by employing divergent and convergent thinking processes as stakeholders discover, define, develop, and deliver a solution to the 'problems' of how best to improve children's motor competence and mental health, and how best to facilitate real-world implementation in school contexts (Table 1) (27). The intention is that the DDDA will enable stakeholder groups to reach consensus on the components and content of a 12-week (i.e., 1 school term) school-based motor competence and mental health intervention, underpinned by social support and perceived competence as key elements of the EESH. To engage the children in the process without them feeling inhibited in expressing their thoughts in the presence of the adults that regularly teach them, they will operate in a single stakeholder group in Stages 1, 2 (after which their discussion points will be shared in Stage 3), 4, and 6. Following this co-production process the 12-week feasibility intervention study will be implemented.

Study outcomes. This is a feasibility study which asks whether the planned intervention can be done, whether it should be developed into a pilot cluster RCT, and if so, how (28). Given the scarcity of previous school-based interventions to simultaneously improve motor competence and mental health outcomes in community samples (14), a number of uncertainties relating to the conduct of a larger trial need assessing (28, 29). These uncertainties represent the primary outcomes and broadly relate to eligibility and recruitment, deliverer capability and training, practicalities of implementation, acceptability of data collection procedures, intervention adherence, and data attrition. These feasibility outcomes will be measured using qualitative

and quantitative methods. In each school we will use focus groups and other appropriate participatory approaches to gain children's views on the intervention activities and data collection methods. Semi-structured teacher and WLSP deliverer interviews will examine intervention acceptability and implementation experiences. The quantitative feasibility outcomes will be evaluated using *a priori* traffic light progression criteria (i.e., green: continue to pilot trial, amber: further discussion and changes needed, red: do not proceed to pilot trial; Table 2) (30).

Thinking processes	Stage	Tasks	Single (SS) or multiple stakeholder (MS) groups
	1	Information workshops on child motor competence (MC) and mental health (MH) in the context of the EESH. These will ensure minimum required knowledge and understanding to engage in subsequent stages	SS
Divergent	2	Discussion of MC and MH in school context and identify what can be done in schools to improve MC and MH	SS then repeat in MS
Convergent	3	Draft intervention component ideas for improving MC and MH over a school term within curriculum and non-curriculum time	MS
Divergent	4	Each MS group presents draft ideas for discussion and feedback from other MS groups	MS
Convergent	5	Each MS group refines their ideas based on Stage 4 and re-presents to other MS groups (e.g., as a visual model)	MS
Convergent	6	Individual participants vote on the Stage 5 models to reach consensus on the preferred co-produced intervention	Individuals

Table 1. Six-stage co-production processes incorporating DDDA in stages 2 to 6

Progression criteria	Red (stop)	Amber (discuss and amend)	Green (go)
School recruitment (targeting N=6)	≤50% of target number	50-90% of target number	≥90% of target number
Child participant recruitment (targeting N≥200)	<20% of eligible children	20-74% of eligible children	≥75% of eligible children
Deliverer recruitment	≥1 teacher and ≥1 WLSP deliverer in <50% of schools	≥1 teacher and ≥1 WLSP deliverer in ≥50%-75% of schools	≥1 teacher and ≥1 WLSP deliverer per school
Intervention dose	<40% of scheduled sessions delivered/week	40-79% of scheduled sessions delivered/week	≥80% of scheduled sessions delivered/week
Intervention adherence	<40% of recruited children attend ≥75% of curriculum lessons	40-69% of recruited children attend ≥75% of curriculum lessons	≥70% of recruited children attend ≥75% of curriculum lessons
Acceptability of intervention	<50% of teachers and children	50-79% of teachers and children	≥80% of teachers and children
Acceptability of data collection methods	<50% of teachers and children	50-79% of teachers and children	≥80% of teachers and children
Secondary outcome data collected at baseline	<50% of children	50-74% of children	≥75% of children
Follow-up secondary outcome data attrition	>40%	26-40%	≤25%

Table 2. Traffic light progression criteria

The secondary outcomes specified below relate to key elements of the EESH (13, 14). Multiple measures will be trialled to assess internalising difficulties and wellbeing as there is uncertainty as to what methods are most appropriate and acceptable. Thus, we will assess internalising

difficulties using the Strengths and Difficulties Questionnaire (31) and Me and My Feelings questionnaire (32), and wellbeing through the Stirling Children's Wellbeing Scale (33) and KIDSCREEN-10 questionnaire (34). To limit participant burden, just one from each pair of these secondary outcome measures will be used in separate sub-samples of children from different intervention and control schools. Motor competence will be measured by the Dragon Challenge dynamic motor competence assessment (35), supplemented by the parent-completed Developmental Coordination Disorder (DCD) Questionnaire (36). Psychosocial stressors and buffers relevant to the EESH and the respective measurement instruments include self-concept (Self-Perception Profile for Children (37)), social support for physical activity (38), peer support (Student Resilience Survey peer connection subscale (39)), social skills (Strengths and Difficulties Questionnaire prosocial behaviour subscale (40)), academic achievement (National Curriculum attainment levels), movement behaviours (24-h wrist accelerometery), and sport participation (Sport England Active Lives Survey for Children and Young People selected questions (41)). As part of our determination of feasibility we will record the time needed to complete the questionnaires and the completion rates. Further, we will examine the responsiveness of these measurement tools to detect changes in the outcomes as a result of the intervention. Data for potential moderators of the relationships between motor competence and internalising problems such as sex, SES (parent education level), Special Educational Needs/Additional Learning Support status, and weight status (42) will also be collected.

Methods of analysis. Thematic analysis (semantic and inductive) of the qualitative data will identify key themes and patterns regarding participants' experiences and perceptions of the intervention. As previously mentioned, although the study is not powered by a formal sample size calculation we do acknowledge the need to ensure we have sufficient participants to provide statistical point estimates and determine parameter variability, which would provide valuable information for a subsequent trial sample size calculation (43). We would analyse these quantitative outcomes descriptively and then with linear mixed models.

Rationale for the design and methods. Mixed-methods approaches will allow us to fully integrate participants' views and perceptions to inform and provide essential context to the quantitative outcomes. We have used these approaches effectively in previous work (44-46).

Ethical issues

The project requires an ethics application to EHU's Science Research Ethics Committee. Ethical approval would be obtained before the project start date and period of active funding.

Service user involvement

Study development. We have developed this proposal in collaboration with WLSP who will integrate the intervention into their physical activity and wellbeing schools provision. We will also engage with pupils, teachers, and school leaders to co-develop the intervention.

Conduct of the study. We will establish a core steering group representing children, teachers, school leaders (with replacement cover for both included in budget), and WLSP to guide the project. Throughout the study we will gather feedback on stakeholders' perceived feasibility and acceptability of the intervention design and methods. Regular project meetings will be scheduled to ensure that all key milestones are achieved in a timely manner.

Dissemination of study findings. With stakeholders we will co-produce digital dissemination materials (e.g., infographics, presentations, videos), to complement more detailed written project reports. We will also organise dissemination workshops and webinars for teachers, deliverers, and local authority public health policy makers. We envision having an open dissemination strategy to the research where we would aim to publicise the work in a range of forums (e.g., academic, education, public health, etc). In keeping with this approach, others would be able to register to access the project resources and use and/or adapt them to suit the requirements of their own schools and students. The registration process would allow us to monitor usage and follow-up to gather feedback and to understand how the resources were being used.

Sources of advice sought
Advice has been sought from a multidisciplinary range of academics, from our established networks of schools, teachers, and from the WLSP Director and Operations Manager.

Costings
Total requested: £59,225 (see budget table in appendix). The full economic cost of the project is £164,958, which includes significant in-kind funding of £107,733 for directly allocated staff, indirect and estates costs, in addition to equipment, consumables, and technical support. We will also use our established networks to facilitate school recruitment. Further, WLSP will provide additional value to the project by adopting the intervention into the planned service delivery in the recruited primary schools. On the basis of the projected project outcomes and requested funds, we believe that the proposal presents strong value for money.

Timescale
15 months project starting 28/2/22. Please see Gantt chart in appendix for details.

Viability
The applicants are experienced in conducting children's motor competence and health research (6, 47-49), often involving larger samples sizes than that proposed here (47, 50-52). SF and LB have published widely on youth movement behaviours and health (49, 53-55), while RT and LF are at the forefront of motor competence assessment research (35). EA is a Chartered Psychologist and researcher in children's mental health and school-based interventions. ZK is a HPC Registered Practitioner Psychologist with recognised expertise in innovative qualitative methodologies with children (56). SF and RT have an established partnership with WLSP (57, 58), which will facilitate school recruitment and intervention delivery.

Summary of job description for the RA post
Please see appendix for the full job description.

Contingency if the application is unsuccessful
Should this application be unsuccessful we would seek funding from alternative sources, such as the ESRC, Wellcome Trust, and the NIHR.

Expected impact of the project
Key beneficiaries and project dissemination to research users and stakeholders. The participating children are the key beneficiaries. Dissemination would include co-produced infographics, videos, presentations (children, schools, WLSP), webinars and workshops (teachers, WLSP, policy-makers). WLSP and teachers would benefit by using the findings to

further develop the content and delivery of their programmes and lessons underpinned by optimising motor skills, and mental health and wellbeing outcomes.

Dissemination. We would use press releases to widen project awareness alongside social media to promote and publicise the findings. We would create blog posts suitable for appropriate online outlets (e.g., The Conversation), and share our work with academic, practitioner, and professional audiences through online forums (e.g., Young Minds, Educate Magazine, The Mental Elf), project webinars, and printed publications. We will publish the findings in gold open access format in peer-reviewed journals, such as *Mental Health and Physical Activity*, which is widely read by our target academic community.

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