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Exploring Well-Being in Thoroughbred Horse Breeding: A Systematic Narrative Review Applying the PERMA+4 Framework

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Abstract

Background: Staff shortages in the horseracing industry may impact horse and staff well-being. Working conditions such as a high workload, and poor work-life balance are found to influence staff retention. Thoroughbred breeders and staff work long hours with limited job control. However, there is a dearth of research examining breeding staff well-being. **Aims:** This article aims to explore associations between working conditions and well-being in thoroughbred horse breeders and stud farm staff. **Materials and methods:** A search of studies published up to January 2025 and available in PubMed, Scopus, and PsycINFO was performed and is reported in line with PRISMA-S. Included articles were deductively coded into predetermined themes using the PERMA+4 framework for work-related well-being (positive emotions, engagement, relationships, meaning, accomplishment, physical health, work environment, mindset, and economic security). **Results:** A total of 21 studies were included for narrative analysis spanning the United States, United Kingdom, Australia, and Ireland. Results suggest that physical and psychosocial working conditions on stud farms may negatively impact staff well-being and retention through poor work-life balance, employee relations, and training and progression opportunities. Well-being may be influenced through the PERMA+4 dimensions of relationships, accomplishment, physical health, and work environment. **Conclusion:** This review demonstrates that the PERMA+4 model may be used as a theoretical framework to understand associations between working conditions and well-being in thoroughbred breeding work. Further research on the application of positive organizational psychology in this sector may increase understanding of and enhance staff well-being and retention.

Keywords

Mental health; well-being; occupational health; horseracing; stud farm staff; working environment

1. Introduction

Working conditions encompass both the working environment as well as conditions of employment such as training, skills, health and safety, well-being, working time, and work-life balance [1]. Two categories of working conditions are generally agreed upon in the literature; the physical and the psychosocial work environment [2]. The psychosocial work environment refers to the psychological and social influences on well-being including; work time, job control, work demands, job security, as well as

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employer-employee relations [2]. An association between working conditions and the well-being of workers has been widely established [3,4]. Specifically, working conditions have been found to significantly contribute to staff retention, job satisfaction, and physical and mental health [5–7].

The horseracing industries of the U.K. and Ireland have long-faced issues around recruitment and retention of staff which may have implications for the welfare and performance of both horses and staff [8]. The horseracing industry encompasses various key stakeholders including jockeys, trainers and stable staff, racecourse staff, and the stud and breeding sector [9]. Staff retention issues in the broader industry have been attributed to a high workload, poor work-life balance, insufficient staff skills, and a lack of career progression [9]. Indeed, almost half of thoroughbred racing and breeding staff plan on leaving their current role in the next two years, while over a fifth plan on leaving the industry in the same timeframe [10]. Among the most common reasons cited by staff were the nature of the work, followed by low pay and lack of career advancement [8].

Attempts to understand the staffing crisis faced by the horseracing industry have highlighted the importance of staff well-being [8]. Well-being encompasses emotional, behavioral, cognitive, and social factors and describes how well an individual feels, functions, and evaluates their life [11]. Well-being in the workplace is increasingly recognized as an important factor in staff retention [12]. Well-being at work is influenced by mental and physical health, occupational hazards, environmental and demographic factors, as well as job satisfaction [13,14]. While there are multiple theories of well-being, the Positive Emotions, Engagement, Relationships, Meaning, and Accomplishment (PERMA) model [15] has been widely adopted in positive psychology research [16]. PERMA offers a multi-dimensional definition of well-being that can be used to evaluate an activity's influence on the key elements of well-being; positive emotions, engagement, relationships, meaning, and accomplishment [17]. Each of these elements is shown to strongly predict well-being and is also associated with improved work performance [18].

PERMA+4 extends the original framework to include four additional elements to explain work-related well-being and performance. These elements are: physical health, mindset, work environment, and economic security [16,18,19]. Previous research on mental health and well-being in horseracing has largely focused on Jockeys [20,21], as well as trainers and stable staff [8,22], research in the breeding sector is lacking. Staff on thoroughbred breeding farms produce horses for racing and work long hours with limited control around time off [9]. Davies *et al.* [23–25] highlighted the significant psychological impact of occupational injuries on stud workers, however little is known about the impact of other occupational factors on stud workers' well-being. While thoroughbred horse breeding is situated within the broader horseracing industry, the occupation shares similarities with farming and the agricultural industry. Farming has been identified as a particularly stressful occupation and farm staff are at an increased risk for mental health problems [26,27]. This perspective article aims to explore associations between working conditions and well-being in horse breeders and stud farm staff. Existing literature on psychosocial working conditions in the thoroughbred breeding industry will be reviewed applying the PERMA+4 model as a theoretical framework to explore their influence on well-being. Specifically, this systematic narrative review aims to answer the following research questions: How do working conditions influence staff well-being in the thoroughbred horse breeding sector? How do working conditions and staff well-being impact staff retention in the thoroughbred breeding sector?

Further empirical evaluation using the PERMA models has the potential to inform policy and intervention development to improve well-being and retention in the breeding sector.

2. Materials and Methods

2.1. Search Strategy

A hybrid systematic-narrative approach was taken whereby search protocols and inclusion/exclusion criteria were informed by systematic review practices, and a narrative approach was applied to the analysis of data [28]. Systematic search strategies prevent bias in literature selection and require a detailed methodology and inclusion criteria that are replicable [29]. The similarity of topic or outcomes between included studies is necessary, therefore a hybrid systematic-narrative approach was deemed most suitable due to the heterogeneity of the research [30]. A review protocol was developed and registered on PROSPERO (CRD42025641832, 23 January 2025). A literature search was conducted in January 2025 across the following databases; PubMed, Scopus, and PsycINFO. Search terms included word variations for working conditions, wellbeing or well-being, and horse breeder or stud farm staff. A full list of search terms can be found in **Table 1**. A manual search of grey literature (industry reports) and reference lists of included papers was also carried out to identify articles for inclusion. A search filter was applied to include full texts and studies in English only.

2.2. Eligibility Criteria

To be included in this systematic narrative review articles must have: (1) included a sample wholly or partially consisting of thoroughbred horse breeding staff; (2) included quantitative or qualitative data on physical or psychosocial working conditions; or (3) assessed mental health or well-being of workers, in line with the aims of this review. Studies were excluded from the review if they met the following criteria: (1) book chapters, or conference abstracts; (2) full text unavailable; (3) not written in English.

2.3. Study Selection

Search results were imported into Covidence, a systematic review manager, and duplicates were removed. Titles and abstracts were screened for inclusion by one researcher (C.M.) using the eligibility criteria. The remaining articles were then screened in full by two reviewers (C.M. & S.N.H.). Any uncertainties were discussed with the research team and a collaborative decision was reached. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection can be found in **Figure 1**. The included studies were then critically appraised for quality using the McGill Mixed Methods Appraisal Tool (MMAT) [31], which is designed for use with reviews including quantitative, qualitative, and mixed methods

studies. All studies met a minimum of 80% of the criteria and were deemed to be of acceptable methodological quality for inclusion.

2.4. Data Extraction

A deductive analytical strategy was employed to apply the theoretical framework to the included data **[32]**. Themes based on components of the PERMA+4 framework (positive emotions, engagement, relationships, meaning, accomplishment, physical health, work environment, mindset, and economic security) were created in the NVivo software. The included articles were then categorized into predetermined themes to extract relevant data. Data on study characteristics are summarized in **Table 2**.

2.5. Data Synthesis

The PERMA+4 framework for work-related well-being was used to guide the synthesis of data. The framework was used to organize the findings and inform how working conditions are associated with and contribute to the well-being of thoroughbred horse breeders and stud farm staff. Interpretation of each of the PERMA+4 constructs is adapted from Donaldson *et al.* **[19]** and is provided in **Table 3**. In line with a systematic narrative hybrid approach, results are discussed in narrative form.

3. Results and Discussion

After title and abstract screening, followed by full-text retrieval, 21 studies were included in this review and are summarized in **Table 2**. Studies were published between 2005 and 2024 and spanned the United States (n = 13), the United Kingdom (n = 4), Australia (n = 3), and Ireland (n = 1). Samples varied but most were representative of thoroughbred horse breeding staff or management. Some studies also included staff from other horseracing industries or veterinarian staff working on stud farms. A variety of study designs were utilized for data collecting including cross-sectional (n = 13), semi-structured interviews and focus groups (n = 4), mixed methods (n = 2), experimental (n = 1), and observational (n = 1).

Table 1: Terms for database search.

Database	Keywords/Boolean
Scopus	work* conditions OR environment OR organizational OR management OR occupational factors OR breed* AND wellbeing OR well-being OR well* OR quality of life OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breed* OR stud farm staff OR stud staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*
PsycINFO	work* conditions OR environment OR organization* OR management OR occupational factors AND wellbeing OR well-being OR well* OR quality of life OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breed* OR horse breeder OR stud farm staff OR stud staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*
PubMed	work* conditions OR work* environment OR organizational conditions OR management OR occupational factors OR breed* AND wellbeing OR well* OR well-being OR quality of life OR wellness OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breeding OR horse breeder OR stud farm staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*

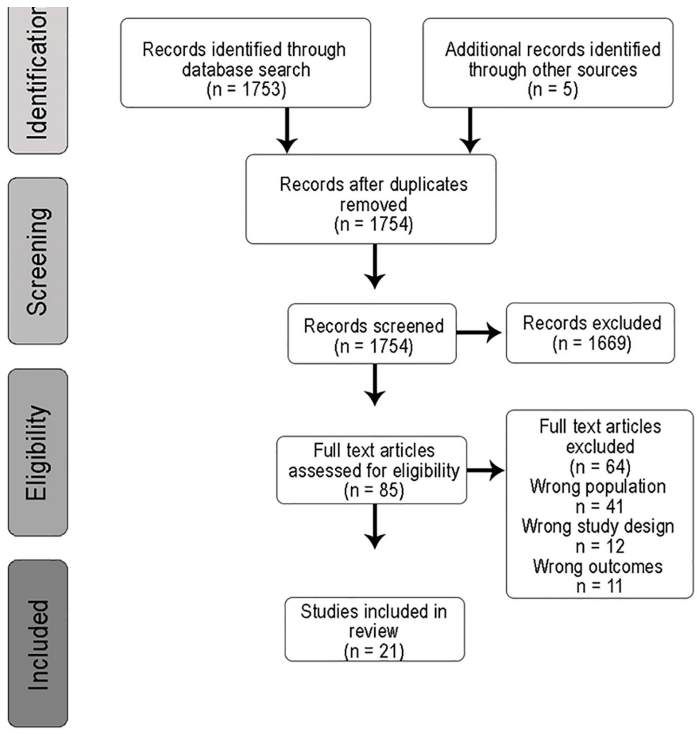

Figure 1: PRISMA flow diagram of study selection.

Table 2: Characteristics of included studies.

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[33]	Hispanic horse workers $N = 225$	$M = 35.4 \pm 9.6$	Male $n =$ 193 (85.8%) Female $n =$ 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (work history, job tasks, working hours, farm size, exposures, work-related stress, health insurance) General health Smoking status Depressive symptomatology	Having children (PR = 1.71, 95% CI {1.03, 2.84}), poor health (PR = 0.72, 95% CI {0.48, 1.08}), work-related stress (PR = 2.58, 95% CI {1.25, 5.32}), and spending time with horses (PR = 1.87, 95% CI {1.15, 3.05}) significantly predicted missed work. Bedding type significantly influenced work-related illness.
[34]	Thoroughbred horse farm managers $N = 35$	N/A	Male $n =$ 26 (74.0%) Female $n = 9$ (26.0%)	United States	Semi-structured interviews	Demographics Working conditions (role, farm size, hazards) Provision of PPE	Horse-related tasks were perceived as the most dangerous. Poor perceptions of PPE efficacy.
[35]	Latino thoroughbred horse farm workers $N = 225$	$M = 35$	Male $n =$ 193 (85.8%) Female $n =$ 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (tenure at current farm, physical demands, work-related stress, supervisor unfairness, supervisor ability to speak Spanish) Work-related injuries	Occupational injury risk was significantly influenced by work stress (OR = 6.70, 95% CI {1.84, 24.31}), supervisor unfairness (OR = 3.34, 95% CI {1.14, 9.73}), longer tenure at farm (OR = 2.67, 95% CI {1.13, 6.34}), and supervisor's inability to speak Spanish (OR = 2.29, 95% CI {1.05, 5.00}).
[25]	British horseracing staff $N = 287$ (breeding sector $n = 18$ (6.3%))	N/A	N/A	United Kingdom	Cross-sectional	Working conditions (employment status, role, job security, employee support) Working practices during COVID-19 lockdown Well-being	Over 87% reported that pandemic-specific work changes were effective, and health and safety were prioritized. Breeding staff were significantly more likely to be working during lockdown compared to jump racing grooms ($p < .05$, 95% CI {2.89, 99.36}). Most sectors reported working the same or fewer hours than before the pandemic, while the breeding sector reported working more hours during lockdown. Over 67% of staff were positive about job security.
[24]	Stable and stud staff $N = 198$ (stud hands $n = 20$)	$M = 34.22 \pm 12.75$	Male $n =$ 37 (18.7%) Female $n =$ 155 (78.3%) Unspecified $n = 6$ (3.0%)	United Kingdom	Cross-sectional	Demographics Working conditions (role, employment status, working hours, pay, job control) Injury details Injury management (attitudes to injury and coping strategies)	Risk factors for injury type included self-perceived job security, working hours, and perceived job control. Consequences of injury included physical limitations, loss of confidence, workplace changes, and lifestyle implications. Attitudes to injury management were influenced by staff shortages, previous injury experiences, and perceived employer expectations.
[23]	British horseracing staff including stable and stud $N = 175$	$M = 34.3 \pm 10.64$	Male $n =$ 29 (16.57%) Female $n =$ 144 (82.29%) Unspecified $n = 2$ (1.14%)	United Kingdom	Cross-sectional	Demographics Working conditions (role, employment status, working hours, pay, job control) Injury details Injury management (attitudes to injury) Social coping behavior Anxiety and depression	A high prevalence of depression and anxiety was found, which was higher for staff who viewed their employer as unhelpful (anxiety $p = .001$; depression $p = .020$).
[36]	Latino thoroughbred horse breeding farm workers $N = 80$	$M = 37.7$, $SD = 10.9$	Male $n =$ 59 (73.8%) Female n = 21 (26.2%)	United States	Cross-sectional	Demographics Job characteristics (duration of employment, hours worked per week, exposures, use of dust masks) Smoking status Respiratory symptoms Pulmonary function	27% showed abnormal pulmonary function. 79% reported any respiratory symptoms, and 94% infrequently used dust masks. Abnormal pulmonary function was associated with shorter durations in the current role (OR = 6.3, 95% CI {1.15, 34.35}) and living in the US (OR = 5.2, 95% CI {1.3, 20.6}).
[37]	Thoroughbred horse farm workers $N = 2276$	N/A	Male $n =$ 1821 (80.0%) Female $n =$ 455 (20.0%)	United States	Cross-sectional	Working conditions (role, contact with horse) Injury details Injury outcomes (i.e. number of days off and injury claims)	Increased risk of high-cost injury for workers with high horse contact jobs (OR = 1.87, 95% CI {1.53, 2.29}).

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[38]	Thoroughbred horse sales stakeholders *N* = 29 (breeders *n* = 11 (37.9%))	N/A	Male *n* = 8 (72.7%) Female *n* = 3 (27.3%)	Australia	Focus groups	Perceptions of yearling sales' endoscopy	Strongly negative perceptions of the yearling sales endoscopy process held across focus groups. The relationship between laryngeal function and future race performance is unclear. A small minority of yearlings with grade three laryngeal function show reduced performance but are earning less generally. Frustration around subjective and inconsistent grading.
[9]	Horseracing staff (focus groups and semi-structured interviews *n* = 131, survey *n* = 1502) including stud sector (focus groups and semi-structured interviews *n* = 7, survey *n* = 143)	N/A	N/A	United Kingdom	Mixed methods (focus groups, semi-structured interviews, and cross-sectional)	Working conditions (role, work hours, work patterns, holidays, benefits, job security) Personal health (injuries, illness, mental health) Mental health services provision Help-seeking Professional development	High rates of stress, anxiety, or depression reported by the stud sector. Poor mental health made worse by their work. Mental health may be influenced by poor communication between management and staff, limited opportunities for development, and tied accommodation.
[39]	Latino horse farm workers *N* = 225	N/A	Male *n* = 193 (85.8%) Female *n* = 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (work-related stress, job security, days missed due to injury, work-related discrimination) Depressive symptomatology	Depression positively correlated with gender (r = .15, p = .04), work stress (r=.15,p=.03),work-relateddiscrimination (r = .27, p < .01), and job insecurity (r = .27, p < .01).
[40]	Latino crop (*n* = 49) and horse breeding workers (*n* = 54) *N* = 103	Horse breeding workers (*M* = 35, *SD* = 9.7) Crop workers (*M* = 32, *SD* = 9.3)	Horse breeding workers (Male *n* = 50 (94.3%) Female *n* = 3 (5.7%)) Crop workers (Male *n* = 48 (97.9%) Female *n* = 1 (2.1%))	United States	Cross-sectional	Demographics Working conditions (farm type, work hours, physical demands, job control, work-related stressors, supervisory practices, supervisory support, safety climate, training, benefits, environmental stressors) General health	Crop workers experienced more physical demands, work-related and environmental stressors, and musculoskeletal and ill-health symptoms. A quarter of both groups reported work-related injury in the last year. Crop workers were significantly more likely to miss work due to work-related illness or injury. A majority of both groups reported exposure to toxic chemicals. A minority received training around toxic chemical use.
[41]	Latino crop (*n* = 49) and horse breeding workers (*n* = 54) *N* = 103	Horse breeding workers (*M* = 35.3, *SD* = 9.7) Crop workers (*M* = 31.9, *SD* = 9.3)	Horse breeding workers (Male *n* = 50 (94.3%) Female *n* = 3 (5.7%)) Crop workers (Male *n* = 48 (97.9%) Female *n* = 1 (2.1%))	United States	Cross-sectional	Demographics Working conditions (working hours, physical demands, work-related stress, supervisor abuse, safety climate) General health	Higher levels of abusive supervision were associated with occupational injury (OR = 2.97, 95% CI {1.0, 8.77}). Awkward postures were associated with occupational illness (OR = 3.85, 95% CI {1.06, 13.98}).
[42]	Horse farm workers *N* = 568	N/A	Male *n* = 476 (83.8%) Female *n* = 92 (16.2%)	United States	Mixed methods (cross-sectional and semi-structured interviews)	Demographics Working conditions (farm size, role, employment status) Injury details	A total of 284 injuries were documented. A large majority of the reported injuries were experienced by men (81.4%) and over half (57.6%) were experienced by non-Latinos. Horse-related tasks were more often associated with general injuries (p = .000), and contusions (p = .033), whereas non-horse-related tasks were more often associated with musculoskeletal sprains, strains, and tears (p = .001), irritations (p = .033), and stings (p = .002).
[43]	Latino thoroughbred horse farm workers *N* = 225	*M* = 35.4 ± 9.6	Male *n* = 193 (85.8%) Female *n* = 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (tenure, time spent working in barns, exposures, availability of dust masks) Respiratory symptoms	Respiratory symptom prevalence was high. Dust masks may be protective. Women and those with a lower understanding of the English language were at higher risk.

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[44]	Latino thoroughbred horse farm workers $N = 225$	$M = 35.4$ ($SD = 9.62$)	Male $n = 193$ (85.8%) Female $n = 32$ (14.2%)	United States	Cross-sectional	Demographics General health Working conditions (tenure, working hours, farm size, job tasks, hazards) Injury details	Nearly half of horse farm workers experienced an injury in the last year, often involving a horse. Bruises, sprains, and strains were most common, as were injuries to upper and lower appendages. Head and face injuries more often result in medical care.
[45]	Latino horse farm workers $N = 225$	$M = 35$	Male $n = 193$ (85.8%) Female $n = 32$ (14.2%)	United States	Cross-sectional	Demographics Working conditions (years working on horse farms, hours worked, safety climate, physical demands) Musculoskeletal discomfort (MSD)	85% experienced MSD, which was associated with higher age ($p = .004$), longer tenure on horse farms ($p = .001$), and longer working hours ($p = .004$).
[46]	Thoroughbred breeding industry workers $N = 29$ (Veterinarians/ Laboratory Personnel $n = 10$ (34.0%), Veterinary Nurses $n = 7$ (24.0%), and stud farm staff $n = 12$ (41.0%)	N/A	Male $n = 9$ (31.0%) Female $n = 20$ (69.0%)	Australia	Semi-structured interviews and focus groups	Demographics Perspectives on the use of Personal Biosecurity practices in the Thoroughbred industry	Greater awareness of infectious risks promotes use of Personal Protective Equipment (PPE). PPE is not comfortable, or practical for equine reproductive work in Australia's hot climate. Supportive environments, strong leadership, and policy and economic factors may influence the adoption of biosecurity and personal biosecurity measures in the workplace.
[47]	Thoroughbred breeding industry workers $N = 17$ (stud farm management $n = 8$, equine veterinarians $n = 6$, equine nurse $n = 2$, and stud farm staff $n = 1$)	N/A	Male $n = 5$ (29.4%) Female $n = 12$ (70.6%)	Australia	Experimental	Changes in adoption of personal biosecurity (PBS) practices Reasons for changes in use of PBS	13 PBS adoption strategies were practiced by at least half of the participants. Participants were more likely to use a ready-made foaling box (98.0%), communicate that PPE is a personal responsibility (94.1%), and use ready-made PPE kits (88.2%). Need for strategies to be sensitive to breeding calendar, farm size, and availability of skilled staff.
[48]	Thoroughbred horse breeders $N = 16$	N/A	Male $n = 12$ (75.0%) Female $n = 4$ (25.0%)	Ireland	Semi-structured interviews	Parasite control practices Attitudes toward reducing anthelmintic use	Pasture hygiene is determined by tradition, rather than biosecurity. Advice on parasite control is not viewed as part of veterinarians' role. Anthelmintic resistance is seen as an industry threat, not an on-farm issue.
[49]	Thoroughbred horses ($N = 321$) and staff working in a veterinary hospital ($N = 125$) and a stud farm ($N = 67$)	N/A	N/A	United States	Observational	MRSA screening Human-horse contact	Total identified cases of MRSA in horses $N = 79$, and staff $N = 25$. Cases from the veterinary hospital (horses $n = 27$ (34.0%), staff $n = 17$ (63.0%)). Cases on a stud farm (horses $n = 41$ (51.0%), staff $n = 8$ (12%)). 96% of human cases had previous contact with horse(s) infected with MRSA. Close contact between horses and humans on stud farms, and extensive movement of thoroughbreds may be risk factors for the spread of MRSA.

3.1. Positive Emotions

Research on positive emotions in breeders and stud farm staff is lacking and studies largely focus on negative emotions. Despite none of the included studies specifically assessing the impact of thoroughbred horse breeding on positive emotions, many assess psychosocial experiences that have previously been linked to positive emotions. For example, Juckes *et al.* [8] found that praise and appreciation from employers for a task done well do not occur often within the horseracing industry. Praise is important to staff well-being through increases in the positive emotion of satisfaction [50]. Rewards and incentives have a similar effect on employee satisfaction [51]. Thompson *et al.* [47] investigated strategies used during foaling to encourage the adoption of personal biosecurity, or practices aimed at reducing infection risk which include Personal Protective Equipment (PPE), as well as social and behavioral interventions. A majority of participants disagreed with the use of rewards and incentives to encourage personal biosecurity with 58.8% citing that biosecurity is necessary and does not require rewards and incentives. Although, participants largely used and valued the use of humor to encourage the adoption of biosecurity. The use of humor in the workplace can help to reduce negative emotions such as tension and soften directives and requests [52,53]. Walshe *et al.* [48] assessed attitudes towards sustainable parasite control practices in Irish thoroughbred breeders and found that current behaviors are driven by tradition which elicits

the positive emotion of confidence. Hammersley *et al.* [54] highlighted the importance of tradition to farmers and that changing agricultural policies may reduce farmer confidence through a perceived loss of mastery. For example, an increasing necessity for paperwork has been a challenge to some more traditional farmers [54]. Positive emotions are more than just the absence of negative emotions, and have been associated with improved work-related well-being and staff retention [55].

Research on stud farms has predominantly focused on negative emotions due to a high prevalence of poor mental health reported by breeding staff [9,23]. Rates of stress, anxiety, and depression have been reported to be high in stud farm staff, with almost 50% stating that their mental health was worsened by the nature of their work [9]. Depression and anxiety are associated with increased negative emotions such as sadness, anger, and fear, and a reduction in the positive emotion of happiness [56]. Furthermore, symptoms of work stress are positively associated with staff retention in terms of turnover intention [55]. Davies *et al.* [23] also found high rates of anxiety and depression in stud and stable staff with injuries. However, as pre-injury anxiety and depression were not assessed it is not possible to establish cause and effect between injury and mental health. It is possible that poor sleep mediates this relationship between mental health and injuries in stud and stable staff. Work patterns of farmers are found to negatively impact sleep quality, and sleep issues have previously been associated with mental health problems in farmers [57,58]. Experiencing poor sleep quality puts farmers at an increased injury risk [59]. Future research should assess the influence of occupational factors on sleep quality in breeding staff, as well as associations with positive and negative emotions. Davies *et al.* [24] assessed the impacts of injury on horseracing staff including stud hands and found that injury could elicit negative emotions such as fear, embarrassment, self-consciousness, and vulnerability. Clouser *et al.* [35] found that 71% of Latino thoroughbred farm workers in the U.S. report that their work is stressful. Experiencing stress significantly increases the risk of missing work in this population [33,39]. The association between stress and absenteeism may be due to mental rather than physical health issues. Swanberg *et al.* [41] found no significant relationship between work-related stress and missed work due to physical illness or injury in horse breeding workers. However, Negi *et al.* [39] found significant relationships between days missed due to physical injury and symptoms of depression in Latino horse farm workers. The most significant predictor of depressive symptoms in this study was work-related discrimination due to race or ethnicity. Workplace racism is negatively associated with employee well-being [60]. Negative emotions such as anger, insult, disappointment, and feeling disrespected are most commonly reported in reaction to racial discrimination [61]. Furthermore, emotional distress caused by workplace racism has previously been found to impact employee turnover intention [62,63].

Fredrickson's [64] broaden-and-build theory suggests that positive emotions may improve well-being over time by building physical, intellectual, social, and psychological resources. For example, experiencing a positive emotion like pride may create an urge to achieve more. In the work environment, the building of personal resources such as resilience and optimism through experiencing positive emotions may buffer against setbacks and reduce turnover intentions [65,66]. The included studies demonstrate a high prevalence of poor mental health in the breeding sector, which is associated with increased negative emotions and reduced positive emotions [56]. According to the broaden-and-build theory, experiencing negative emotions narrows thought-action repertoires in order to fight or flight a threat [64,67]. A negative emotion such as fear may create an urge to escape a situation thereby offering short-term, immediate benefits in threatening situations [68]. This could explain the association between work-related stress and turnover intentions as staff may leave their job to escape the experience of negative emotions [55]. Furthermore, experiencing positive emotions at work is thought to decrease stress symptoms, improve job satisfaction, and reduce turnover intentions [55,69]. While there is a lack of research exploring the experience of positive emotions in thoroughbred breeding, an industry report found that 85% of stud workers experience satisfaction in their job, citing their love and passion for horses as the main reason [10]. It is recommended that future research investigate the influence of positive and negative emotions on the well-being and turnover intentions of breeders and stud farm staff. In particular, research on the positive emotions experienced by stud workers through working closely with horses is recommended. Interventions to enhance positive emotions at work such as education programs on positive communication and mindsets may improve breeding staff well-being and retention [55].

Table 3: PERMA+4 interpretation [19].

Construct	Interpretation
Positive emotions	Experiencing positive emotions such as happiness, joy, love, or gratitude in the moment.
Engagement	Being highly absorbed, or experiencing flow while engaged in a task.
Relationships	Maintaining positive relationships with others, characterized by experiences of love and appreciation.
Meaning	Being connected to or serving something larger than oneself, or having a sense of purpose.
Accomplishment	Experiencing mastery or achieving important or challenging work goals.
Physical health	Demonstrating high levels of biological, functional, and psychological assets.
Mindset	Having a growth mindset, characterized by optimism and viewing challenges and setbacks as opportunities for growth.
Work environment	A psychophysical system consisting of both physical factors such as building design and air quality, and subjective experiences including safety and connectedness.
Economic security	Perceived security and stability of finances to satisfy individual needs.

3.2. Engagement

Engagement at work may be negatively affected by staff retention issues in the breeding industry. Horseracing staff shortages means there is sometimes an imbalance between the personal skills of and the demands placed on staff. Juckes *et al.* **[8]** identified a skills gap whereby less experienced staff are lacking practical skills such as riding ability and caring for horses. Recently employed staff who would normally learn from experienced staff may miss out due to a high staff turnover. Engagement refers to being highly absorbed in or experiencing flow while engaged in a task **[15]**. According to Csikszentmihalyi **[70]**, flow occurs at the intercept of personal skills and challenge levels. As horseracing staff including breeders and stud farm staff may be under pressure to work harder and with a higher level of skill than would be normally expected, staff shortages may negatively impact engagement **[8]**. Furthermore, self-determination theory **[71]** suggests that an individual must feel they are competent to perform an activity in order to be motivated to engage in it and to reach a flow state **[72]**. Staff competency may be limited by staff shortages as well as a lack of training and development opportunities reported by some of the included studies **[9,40]**. A recent survey of thoroughbred breeding staff in the U.K. found that job satisfaction was influenced by training, development, and career progression opportunities and that these influence leaving intentions **[10]**. Employees who are satisfied with the training provided by their organization are more likely to be engaged at work and less likely to leave their role which highlights the importance of engagement at work to staff retention **[73]**.

Engagement at work is also related to satisfying the basic need for autonomy, another component of self-determination theory **[74,75]**. Staff autonomy around work shifts, hours, and responsibilities is referred to as job control **[76]**. Stud farm staff have identified a lack of control around taking time off as one of the most significant stressors in the workplace **[9]**. Job control was also previously identified as a risk factor for injury in horseracing staff **[24]**. According to the demand-control model **[77]**, job stress is determined by two parameters; job demands and decision latitude, or autonomy. In addition to offering limited autonomy, jobs in the horseracing industry including the breeding sector place significant physical and mental demands on staff **[78]**. Thus, high job demands coupled with limited job control may impact stud farm workers' well-being through increased stress and low engagement at work **[76,79]**. Swanberg *et al.* **[40]** found that only between one-quarter and one-third of horse farm workers report almost always being able to make decisions about what or how to do their job. Similarly, Davies *et al.* **[24]** found that 36.2% reported having complete or a lot of control over their job, while 35.5% reported little to no job control. McConn-Palfreyman *et al.* **[9]** identified a lack of flexibility on stud farms around taking time off with employees feeling pressure to work seven days per week. While none of the included studies assessed flow or engagement in stud farm staff or breeders, fulfillment of related psychological needs of competence and autonomy at work appears to be low. This may impact staff retention in the breeding sector as engagement at work has previously been found to predict employee intentions to leave in other industries **[73,80]**. Future studies should assess flow states in stud farm workers and their influence on staff well-being and retention.

3.3. Relationships

Relationships between stud farm employees, and between employers and employees appear to have a significant influence on well-being in the horse breeding industry. Within horseracing broadly, Butler *et al.* **[81]** found poor communication, criticism, and a lack of recognition from employers to employees were prevalent. Furthermore, this was found to negatively impact attitudes, behavior, and staff retention which highlights the importance of communication in building positive relationships between horseracing management and employees. In contrast, positive relationships in the workplace were found to mediate the association between organizational support and intentions to leave jobs **[82]**. Studies on the influence of relationships on employee engagement, satisfaction, and learning in the workplace have highlighted the importance of psychological safety **[83]**. In particular, positive leader relations are influential in shaping the work environment and fostering psychological safety **[83]**. In McConn-Palfreyman *et al.* **[9]**, stud managers identified a need for training to enhance their interpersonal skills such as listening to and motivating staff, in order to improve relationships and create a supportive environment. Relationships contribute to well-being through the sharing of positive events, showing interest, emotional engagement, and offering support **[84]**. Stud staff in this study reported a lack of support from employers surrounding injury rehabilitation and time off work for injury **[9]**. Employers can support injured employees through adaptations to job tasks and hours with consideration for injury type and physical limitations **[24]**. A lack of employer support has implications for staff retention, as managers can influence turnover intentions by improving the support provided to employees **[82]**. Davies *et al.* **[24]** also found that over 41% of staff reported their employer as unhelpful during periods of injury. In addition to turnover intentions, a lack of employer support following injury may impact an employee's return to work and mental health **[23,85]**. Davies *et al.* **[23]** found that injured stud and stable staff who perceived their employer and support networks as unhelpful reported higher levels of depression and anxiety. Relationships between supervisors and staff may also impact mental health through discrimination. Negi *et al.* **[39]** found that discrimination at work due to ethnicity was significantly associated with depression in Latino horse farm workers, although Clouser *et al.* **[35]** found that just 11% of Latino horse farmers reported being treated unfairly by their supervisors. However, supervisors' inability to speak their language significantly increased staff risk for occupational injury which highlights the importance of communication between leaders and staff on stud farms. Similarly, Swanberg *et al.* **[41]** found that reported abuse between supervisors and subordinates was low, yet there was a significant relationship between abusive supervision and health outcomes including injury, illness, and missed work, demonstrating the importance of leader relations and support to staff well-being. The physical well-being of staff is also influenced by relationships with leaders. For example, in Australia, managers and supervisors reported a responsibility to staff well-being through promoting the use of PPE **[46]**. Supervisors in this study expressed the need to

lead by example in order to create a workplace culture where everyone adopts PPE. However, in the U.S., many Latino horse workers disagreed that safety practices were prioritized with over half stating that supervisors were just interested in having the work completed quickly and cheaply [40].

In addition to leader relations and influence, peer support between employees is also key to fostering psychological safety in the work environment [83]. The prevalence of workplace bullying in training yards is found to be high and has been identified as a stressor for stable staff [9,22,86]. Rates of workplace bullying is particularly high for female stable staff. Workplace bullying is consistently associated with increased depression, anxiety, and stress [87]. Workplace bullying has not previously been assessed on stud farms. However, stud farm staff report that relations with colleagues are a significant stressor [9]. Furthermore, the long working hours required in the breeding sector impact relationships by causing an imbalance between work and personal life. McConn-Palfreyman *et al.* [9] found that many staff reported feeling isolated from others outside of the stud, and living away from family among their main stressors. In addition to impacting mental health and well-being, relationships on stud farms also impact mental health help-seeking as staff reported a need to appear strong to colleagues as the most significant barrier to engagement with mental health services [9]. However, this study did not use validated measures and as a consequence, further research on mental health and help-seeking in stud farm staff is recommended. The included studies demonstrate the importance of relationships to staff well-being, in particular relations between employees and employers. The findings suggest that a lack of support from employers and peers negatively impacts psychological safety and mental health on stud farms. Workplace bullying incidence is found to be high in stable yards, in particular for female employees [22,86]. However, there is a lack of research assessing the influence of employee relations on well-being. Based on these findings, research on gender differences in workplace relationships and communication within the breeding sector is recommended.

3.4. Meaning

Horseracing jobs are unique in that for many employees working with horses is viewed as a way of life [9]. Breeding staff are motivated to work in the industry by their interest in and love for horses. While pursuing a career centered around leisure interests may provide meaning, it may also demand acceptance of challenging working conditions [88]. This is similar in farming as the occupation is viewed as more than a source of employment but rather a lifestyle, which influences farmers' identity and reduces their likelihood to seek help [89]. Ní Laoire [90] suggests that farmers accept challenging conditions and prioritize farm work over self-care, in the pursuit of a masculine identity. Individuals develop identity through searching for meaning in life, generally in adolescence. Identity continues to develop throughout the lifespan and is subject to change due to development, and interactions with the environment [91]. In the thoroughbred breeding industry, 60% of stud farm staff report living on-site [9]. While this has benefits for employees such as financial security, it may have a significant influence on their identity [92]. McConn-Palfreyman *et al.* [9] suggested that some stud farm staff are at risk of overconforming to their work role to the point that it informs their identity. For example, in sports, athletes are expected to conform to a set of norms such as striving for perfection, choosing sport over personal life, taking risks such as playing through injury and having no limits in the pursuit of excellence [93]. Overconforming athletes may attempt to prove their commitment by exceeding reasonable limits. When an athlete pursues an athletic identity and neglects other life roles it may negatively affect their well-being [94]. Similarly, stud farm staff who overconform to their work identity and neglect other life roles may experience negative impacts on their well-being.

Overworking and difficulties with maintaining a work-life balance have been reported by stud and breeding sector employees [9]. Similarly, farm workers have reported low satisfaction with work-life balance [95]. Racing staff work long hours often including weekends [22]. Swanberg *et al.* [43] found that thoroughbred breeding farms defined full-time work as 48 hours per week, over six days [43]. However, during the breeding season many staff on stud farms reported working in excess of 12 hours a day [9]. Furthermore, staff who live in tied accommodation reported a requirement to be available 24 hours a day should problems arise with the horses overnight [9]. It is suggested that tied accommodation may contribute to the all-encompassing nature of horseracing work and negatively impact staff well-being through poor sleep, nutrition, and social life practices [9]. While meaning in work may positively influence staff well-being, a lack of boundary between work and life due to horse care requirements and the proximity of workers to the farm may negatively impact well-being in the breeding industry. Meaningful work influences work engagement, commitment, and job satisfaction which in turn influences work performance and intentions to leave jobs [55,96]. While industry reports indicate that a poor work-life balance offered by the breeding industry, exacerbated by tied accommodation may negatively influence stud workers' well-being, there is a lack of validated measures to confirm this [9,10]. Further research on the influence of tied accommodation on breeding staff identity and well-being is recommended [9].

3.5. Accomplishment

Accomplishment at work may be hampered by a lack of opportunity for career progression has been reported by stud farm staff [9]. According to Hendry and Kloep's theory of lifespan development [97], life is a series of challenging and routine tasks. If an individual continues to accomplish only routine tasks, this leads to stagnation. Where an individual fails to meet the challenge or to take the risk, this will result in decay. However, when the individual meets the challenge, development occurs having a positive impact on well-being. In the breeding sector, a lack of opportunity for career progression has been reported by stud farm staff [9]. In line with Hendry and Kloep's theory [97], a lack of opportunity to engage in challenging tasks and experience accomplishment may cause stagnation. Described as a 'glass ceiling', the lack of progression offered by the sector is reportedly having a negative impact on employee well-being as well as staff retention [9]. When asked to rank stressors, 29% of stud staff reported that searching for career progression was the

number one source of job stress. Furthermore, a reported skills-gap has been recognised in the wider horseracing industry meaning stud staff may lack competence [9]. Competence is a close relative of accomplishment and is regarded as one of the three basic psychological needs one must fulfill [98]. It is suggested that employees must feel competent in order to be motivated to accomplish at work. Meeting all of these needs can lead to positive outcomes to an individual's well-being such as increased life satisfaction and positive affect, while not meeting one or more needs leads to negative outcomes such as increased negative emotions [98,99]. According to McConn-Palfreyman [9], there is a lack of availability for staff training, and in particular for management. This negatively impacts well-being through increased stress for individuals wishing to progress and pursue managerial opportunities. Similarly, Swanberg *et al.* [40] reported a lack of employee training with 22% of horse workers having received no training whatsoever. This is particularly concerning as Juckes *et al.* [8] identified a lack of employee and management skills as a contributing factor to staff retention issues. Research on the impacts of employee training and career progression on breeding staff well-being is lacking. Future research should consider interventions around increasing training and progression opportunities for individuals in the breeding sector.

3.6. Physical Health

Working in the breeding sector appears to negatively influence physical health through an increased risk of injury and illness [37,40,42,44]. The risk of injury for staff on thoroughbred breeding farms and training yards has been reported to be considerable. Davies *et al.* [23] found that stud and stable staff reported an average of four injuries per year. Swanberg *et al.* [44] found that nearly half of thoroughbred horse farm workers experienced an injury in the last 12 months. Swanberg *et al.* [40] revealed that a quarter of horse farm workers experienced a work-related injury in the previous year. Stud farm jobs that involve high contact with horses carry an increased risk of injury [34,37]. Horses, in particular those bred for racing, are known to be strong and temperamental [42]. Indeed, horses are responsible for over half of the injuries sustained, mainly through kicks, strikes, or being trampled or stepped on [42]. Leading, grooming, and breeding horses were cited among the most dangerous tasks alongside breaking yearlings [34]. The most prevalent injuries to stud and stable staff include bruising, lower back pain, muscle strain, and neck pain [23]. Swanberg *et al.* [45] found high prevalence rates of musculoskeletal discomfort in Latino horse farm workers in the U.S. which was associated with longer tenure on horse farms and longer work hours.

While horses are responsible for a large proportion of injuries sustained, there are other occupational injury risks present on stud farms and training yards. Stud farm work may require heavy lifting of horse feed, hay, or muck which has the potential for injuries [34]. Furthermore, farm equipment such as tractors and hay balers have the potential to cause injury. Individuals engaged in non-horse related tasks are at greatest risk of injuries to the back, knee, and neck as well as musculoskeletal sprains, strains, and tears [42]. Injuries have negative consequences on staff well-being such as physical limitations, loss of confidence, workplace changes, and lifestyle implications [24]. They may also impact mental health as Davies *et al.* [23] found that a majority of injured staff were experiencing mild to severe anxiety, while over half scored over the threshold for depression [23].

In addition to injury, the physical health of stud farm staff may be impacted through work-related illness. Working in horse breeding carries the risk of zoonotic disease through activities such as live breeding and foaling [46]. Weese *et al.* [49] found high rates of MRSA in staff at a thoroughbred stud farm which was likely transmitted during contact with infected horses. Furthermore, thoroughbred horses move frequently between farms for breeding which increases the risk of zoonotic diseases spreading [49]. The bedding type used in barns significantly influences work-related illness in horse workers [33]. Horse farm workers have reported high prevalence rates of respiratory symptoms [36,43]. Physical health is also impacted by staff management of illness and injuries, which may be influenced by staff shortages [24]. A lack of available cover may influence the time staff take to recover from illness and injury. Indeed, the likelihood of stud and stable staff reporting injuries, seeking treatment, or resting for recovery is low [24,42]. This could be attributed to a culture of presenteeism, which obliges staff to show up when ill or injured [9,24]. Sickness presenteeism negatively impacts staff well-being through an increased risk of future absence due to illness and poorer overall health [100]. Furthermore, presenteeism has been found to positively relate to turnover intention [101]. While current research has focused on the negative impacts of horse breeding on physical health, future research may benefit from a positive psychology approach to assessing the influence of this work on physical health with the aim of enhancing staff well-being and retention. For example, working with and owning horses may offer natural opportunities to benefit physical health and well-being such as through reaching recommended physical activity levels, and spending time in nature [102,103]. Indeed, research in farming has identified therapeutic aspects of the work [104]. In particular, being outside in nature and engaging in physical labor offers opportunities for physical and mental well-being that managerial and administrative duties do not.

3.7. Mindset

While mindset was not assessed in any of the included studies, working conditions in the breeding industry may have a negative impact on mindsets. A growth mindset is characterized by future orientation, optimism, and viewing challenges and setbacks as opportunities for growth [105]. Such opportunities may be limited in the breeding sector as a lack of career progression has previously been reported [9]. Specifically, there is a belief in a 'glass ceiling' whereby regardless of effort at work, there is little opportunity for progression. This is an example of learned helplessness, where repeated exposure to uncontrollable events results in the belief that an individual is unable to change their situation and gives up trying [106]. The concept is similar to a fixed mindset as giving up is a common factor [105]. Combined with the lack of progression offered, participants suggested that the hard work required by the breeding sector negatively impacts staff retention [9]. In a fixed mindset, individuals view effort as fruitless and tend to give up easily [105]. Injuries may also elicit a fixed mindset as Davies *et al.* [24] found participants report decreased work

ethic and feelings of redundancy following injury. Fixed mindsets negatively affect well-being through increased negative affect [107]. Furthermore, individuals with a growth mindset show increased well-being and resilience [108,109]. However, there is no current research on the mindset or resilience of breeding staff. Future research on mindset and its influence on resilience and turnover intention in the breeding sector is recommended.

3.8. Work Environment

Breeding sector staff are exposed to various environmental stressors which may impact their well-being through physical health. Air quality in barns may affect stud workers' well-being through respiratory health [34,36,43]. Bush *et al.* [33] found that the bedding type used in barns significantly influenced work-related illness in Hispanic horse workers. Specifically, staff who used straw bedding in barns were over three times more likely to miss work due to work-related illness than those who used sawdust bedding. Furthermore, a majority reported that their symptoms improved when they were away from the barn for more than one day suggesting that dust from straw may cause respiratory symptoms.

Safety climate may also influence well-being in the breeding sector. Safety climate encompasses the provision of safety training and equipment, and information regarding safety hazards [110]. PPE may protect against environmental risk factors on stud farms. On finding a high prevalence of respiratory symptoms in thoroughbred horse farm workers, Swanberg *et al.* [43] recommended the use of dust masks in barns. Flunker *et al.* [36] also found high rates of respiratory symptoms in horse breeding farm workers, with a majority reporting infrequent use of dust masks. PPE may also protect against the risk of zoonotic infections but risk awareness and PPE use in the breeding sector appear to be low [46]. Despite the known injury risks of grooming and leading horses, PPE is rarely used during unmounted horse-related tasks [34]. On many farms, horse-related PPE such as helmets and padded vests are considered necessary only while riding or live-breeding. The provision of PPE may also be low and may be limited by managers' perceptions of their effectiveness [34]. In addition to protective equipment, safety training may be low. Swanberg *et al.* [40] found that a majority of horse farm workers reported being exposed to toxic chemicals, while a minority received training around their use. In Clouser *et al.* [34], most participants were aware that administering medicines to horses required gloves but did not know the reason. The included studies reveal conflicting evidence for the safety climate on stud farms. While Davies *et al.* [25] found that staff health and safety were prioritized during the COVID-19 lockdown, Swanberg *et al.* [45] found that a poor safety climate was associated with elevated musculoskeletal discomfort in U.S. horse farm workers. Further research into the safety climate on stud farms is necessary to establish recommendations on the provision of training and safety equipment.

3.9. Economic Security

Dissatisfaction with wages is not found to be a major contributor to staff retention in the horseracing industry, but this may vary across locations [8]. Davies *et al.* [24,25] found that a majority of stud and stable staff felt secure in their current role. Although staff were statistically more likely to report feeling insecure in their job if they had experienced concussion, or a fracture to the leg, foot, rib, or spine in the last 12 months [24]. This may have implications for injury reporting and taking time off due to injury [24]. Workers have cited finances as the most common reason for coming to work while ill [33]. Although a majority of workers in this study reported receiving compensation for injury or illness acquired at work, just over half receive pay for days missed due to illness. Job insecurity is found to positively correlate with depressive symptoms [39].

In addition to concerns around job security, individuals working in the breeding sector may face financial hardship. Swanberg *et al.* [111] reported that U.S. horse farm workers received an average hourly wage of $10.24. This is low when compared to the national average hourly wage in December 2019 of $28.32 [112]. In the U.K., the majority of the stud and breeding workforce earned between £20,000 and £29,000 per year [9]. This figure is also found to be lower than the U.K. national averages for the same year [113]. Finances may also impact biosecurity practices on stud farms [34,48]. For example, disparities in the provision of PPE are seen between different farm sizes [34]. However, only a small number of farms cited finances as a factor in PPE provision. Similarly, Taylor *et al.* [46] found that while economic factors contributed to the adoption of biosecurity and personal biosecurity measures at work, the cost of PPE was not a major factor. In Walshe *et al.* [48], breeders highlighted cost as one of the main barriers to fecal sampling as a method of sustainable parasite control. Hardwick *et al.* [38] also highlighted the influence of economic security on thoroughbred breeders' well-being. Specifically, this study identified perceptions of endoscopic examinations performed at Australian yearling sales to grade laryngeal function. Despite concerns around Veterinarian subjectivity in grading, and a lack of clarity around whether lower grade laryngeal function predicts future performance, yearlings identified with grade three function sell at reduced prices. Participants identified this as having a significant impact on the livelihood of breeders [38]. Overall, dissatisfaction with wages is not found to be a major contributor to staff retention in the horseracing industry [8]. However, findings suggest that some workers experience job and economic insecurity following absence due to injury or illness [24,33]. This is concerning for staff well-being and further research into job security and satisfaction in the breeding sector is recommended.

4. Recommendations

This exploration is limited by a lack of research in the thoroughbred horse breeding industry. Furthermore, while care has been taken to ensure methodological rigor and transparency, systematic reviews are susceptible to potential biases, such as selection bias and random error [114]. Further empirical research on the dimensions of positive and negative emotions, engagement, and meaning at work is recommended. Research on the application of positive organizational psychology in this sector may increase understanding of and enhance breeding staff well-being and retention. Specifically, the application of the PERMA framework may inform the development of interventions aimed at increasing aspects of well-being in the thoroughbred breeding industry. For example, education programs on positive communication and mindsets may

enhance positive emotions and work and thereby improve breeding staff well-being and retention [55].

5. Conclusion

This systematic narrative review has demonstrated the potential of the PERMA+4 model to increase understanding of the influence of working conditions on breeding staff well-being. This is necessitated by a staffing crisis in the wider horseracing industry, and an established association between work-related well-being and staff retention [55]. Specifically, findings suggest that physical and psychosocial working conditions inherent in the breeding industry may negatively impact well-being through work-life balance, occupational injuries and illnesses, employee relations, and a lack of opportunity for training and progression. Breeding staff are at risk of poor mental and physical health through the PERMA+4 dimensions of relationships, accomplishment, physical health, and work environment. These factors, in particular a poor work-life balance and lack of progression opportunities, may also impact staff leaving intentions. However, validation through empirical research is necessary.

Authors' Contributions

Conceptualization; C.M., methodology; C.M., formal analysis; C.M., validation; S.N.H., writing - original draft; C.M., writing - review and editing; C.M., S.C., S.O.C., G.W., C.N., J.P., A.M., and C.L., All authors have read and agreed to the published version of the manuscript.

Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

Not applicable for this study as it involved only previously published data.

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