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Unsettled horizon: adolescents' career expectations in the volatile, uncertain, complex, and ambiguous contexts

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Navigating the school-to-work transition is essential for students in the volatile, uncertain, complex, and ambiguous (VUCA) environment. Despite the growing importance of understanding these challenges, the differential impact of proximal and distal contexts on adolescents' career decision-making remains underexplored. This study is grounded in Social Cognitive Career Theory (SCCT), which highlights self-efficacy, outcome expectations, and contextual influences in career decision-making. Using data from the Programme of International Student Assessment 2022, we applied multilevel linear models to examine how VUCA contexts shape adolescents' career expectation uncertainty across 80 diverse educational systems. Results reveal that (a) the proportion of adolescents uncertain about their career plans nearly doubled after the pandemic and persisted in certain economies; (b) proximal environments (school and individual inputs) explained only 10% of the uncertainty, while distal contexts (economic conditions) accounted for 65%; (c) students with lower self-efficacy and inadequate future preparation were more susceptible to career indecision; (d) higher youth NEET (Not in Employment, Education, or Training) were positively associated with career indecision, especially disadvantaged students; and (e) educational disruptions had minimal impact on career decisions, while girls benefited more from targeted career guidance.

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Unsettled horizon: adolescents' career expectations in the volatile, uncertain, complex, and ambiguous contexts

The rapid advancement of technology, coupled with socio-economic instability, has introduced unprecedented challenges to youth career decision-making. The concept of Volatility, Uncertainty, Complexity, and Ambiguity (VUCA), originally introduced in the field of management, has expanded to encapsulate various aspects of life, particularly in the post-pandemic era (Taskan et al. 2022). Among the VUCA components, uncertainty—characterised by the lack of essential information necessary to predict future events—poses substantial challenges to human cognitive processes, impeding individuals' ability to interpret information and make informed decisions (Chater, 2020; Colquitt et al. 2012). Adolescents at a crucial stage of career exploration and identity formation are particularly vulnerable to the effects of such uncertainty (Branje et al. 2021). While traditional career theories focus on individual-environment fit, they offer limited explanations for how external challenges influence career decision-making. In contrast, Social Cognitive Career Theory (SCCT) provides a more comprehensive framework by explicitly incorporating self-efficacy, outcome expectations, and contextual affordances, making it particularly relevant in VUCA environments.

SCCT posits that students' perceptions of their proximal and distal environments and preparedness for disruptions play a critical role in shaping their educational and occupational choices (Lent et al. 2000; Lent and Brown, 2020). In the post-pandemic VUCA environment, unforeseen economic fluctuations, rising unemployment rates, and the rapid development of artificial intelligence (AI) have exacerbated the anxiety and confusion among young people regarding their future career paths. Furthermore, the direct impacts of school closures and inadequate career guidance have disrupted students' learning processes and their ability to make well-informed career decisions (Jemini-Gashi and Kadriu, 2022). In light of these circumstances, it is crucial to examine the environmental and personal factors that contribute to uncertainty in adolescents' career expectations. This study aims to explore the effects of national development indicators, school contexts, and students' characteristics on adolescents' career expectation uncertainty.

Moreover, students from disadvantaged backgrounds and girls may be particularly susceptible to the effects of the VUCA environment due to the digital divide and limited family resources available to cope with socioeconomic shifts. In high-income countries, the relative social deprivation experienced by disadvantaged students may further exacerbate these challenges (Pettigrew et al. 2008). Enhanced NEET (Not in Education, Employment, or Training) rates, particularly among girls (International Labour Organisation [ILO], 2020), can further obscure young people's perceived employment opportunities. Given the significant role of contextual factors in shaping employment prospects (Akkermans et al. 2024; Kovalenko and Mortelmans, 2016), it is crucial to unravel the interaction between personal background and environmental factors, thereby facilitating a better understanding of youth career indecisiveness.

Uncertainty in adolescents' career expectations. Career expectation refers to adolescents' realistic and attainable career ambitions, grounded in their self-perceived competencies, personality traits, and family background (Arbona and Novy, 1991). This concept, inherently tied to reality, exhibits considerable stability over time and significantly influences social status and occupational outcomes later in life (Hoff et al. 2022; Ashby and Schoon, 2010). Adolescents with ambitious career goals, such as aspiring to become scientists, are more likely to pursue and attain degrees in science and engineering (Tai et al. 2006). Clear and decisive career expectations are critical in motivating behaviours that lead to achieving desired career outcomes. However, a considerable proportion of adolescents aged 10–19 experience uncertainty concerning their career plans in their 30 s (Guo, 2022; Sikora, 2018), often due to limited information about the labour market and inaccurate self-assessments. In this study, the inability to articulate clear career expectations is referred to as career expectation uncertainty.

Previous longitudinal studies have highlighted the adverse effects of indecisive career expectations on subsequent adult achievements. For example, Greve et al. (2021) used data from the Programme for International Student Assessment (PISA) 2000 and administrative records from 2004 to 2014 to demonstrate that uncertain career expectations are associated with lower educational attainment and weaker labour market integration, particularly among males and disadvantaged groups. Similarly, research based on the British Cohort Study found that misaligned and uncertain career expectations at age 16 lead to significant deficits in employment stability and wage earnings by age 34, unless individuals obtain higher education qualifications and part-time employment in adulthood (Sabates et al. 2011; Sabates et al. 2017).

Conversely, having clear and decisive career expectations during adolescence allows for extended educational and occupational preparation, thereby increasing the likelihood of achieving favourable career outcomes. Empirical evidence supports that definitive career aspirations at age 16 are associated with higher educational attainment and greater hourly wages by age 26, regardless of gender, ability, effort, or SES in the United States (Staff et al. 2010). Although different educational systems offer varied opportunities for educational advancement, missing critical windows for selecting appropriate educational and occupational paths can result in higher costs if changing goals later (Schoon and Heckhausen, 2019). In the context of VUCA, adolescents' career prospects are further clouded by educational disruption and technological advancement, making it imperative to gain a deeper understanding of the factors influencing young people's career indecision across various educational systems.

Social cognitive career theory. SCCT offers a valuable theoretical framework for unravelling the interplay between personal and environmental factors in adolescents' career expectations. Introduced by Lent et al. (1994), SCCT emphasises the critical roles of outcome expectations, self-efficacy, and goals in shaping individuals' educational and occupational choices and performance. Outcome expectation refers to the anticipated physical and psychological outcomes of specific behaviours, addressing the question, "If I do it, what will happen?" Meanwhile, self-efficacy indicates the perceived competence in accomplishing specific tasks, answering the question, "Can I do it well?" The dynamic interaction between self-efficacy and the environment profoundly impacts personal choices and efforts in sustaining goals despite obstacles (Lent et al. 1994). SCCT also underscores the importance of contextual affordances that significantly shape cognitive-personal variables (e.g., self-efficacy, outcome expectations, and goals) and influence individual career interests and choices.

Given the learning disruptions experienced during the pandemic and the challenges posed by a rapidly changing labour market with technological advancements, young people's career planning is likely to have been substantially influenced. Yet, the full extent of this influence remains underexplored. SCCT categorises environmental factors into proximal/immediate contexts (e.g., role models and school climate) and distal/societal contexts (e.g., economic conditions and employment opportunities) that influence individual career interests and goals (Lent

et al., 2000). Importantly, Lent et al. (2000) highlighted the relative scarcity of empirical evidence examining environmental barriers that hinder the translation of interests into goals and goals into actions. This study, therefore, examined the combined influence of distal and proximal environmental factors on adolescents' career decision-making processes and their interactions with students' personal backgrounds.

SCCT provides an optimal framework for this study as it uniquely integrates both cognitive-personal and environmental influences on career decision-making, making it particularly relevant in the VUCA context. Unlike other career theories, which primarily focus on individual-environment fit (e.g., Holland's Person-Environment Fit Theory) or life-span development (e.g., Super's Life-Span Theory), SCCT explicitly incorporates how external disruptions—such as economic instability, school closures, and technological advancements—interact with personal factors like self-efficacy and outcome expectations. Given the sharp increase in career expectation uncertainty among adolescents post-pandemic, it is essential to consider how both proximal factors (e.g., school guidance, preparedness for uncertainty) and distal factors (e.g., youth NEET rates, gross domestic product [GDP], and pandemic-related disruptions) contribute to career indecision. SCCT's emphasis on the reciprocal interactions between individuals and their environments allows for a more nuanced analysis of how students navigate career planning in uncertain times.

Impacts of the VUCA environment. The term VUCA was initially applied in the business field to describe unstable, chaotic, and rapidly changing work settings. However, in the aftermath of the pandemic, it has been extended to describe the multifaceted challenges that individuals encounter daily (Taskan et al. 2022). The accelerated adoption of technology, including AI, and the unforeseen replacement of jobs in the labour market further complicate youth career decision-making processes. Moreover, prolonged learning disruptions due to school closures and the widespread dissemination of incomplete or misleading information have exacerbated confusion among adolescents. These factors contribute to self-doubt, limiting cognitive and behavioural responses (Yoon et al. 2021), and hampering their ability to make informed and decisive career decisions (ILO, 2020). Consequently, the uncertainty of adolescents' career expectations is likely to increase significantly in a VUCA environment.

However, governmental responses to technological change and the impacts of the pandemic have varied across countries. Gender disparities and socioeconomic stratification have further exacerbated educational vulnerabilities among females and youth in less-developed regions (Burzynska and Contreras, 2020; ILO, 2020). Additionally, boys and students from low socioeconomic backgrounds already exhibited higher levels of indecisiveness regarding their career aspirations before the pandemic (Greve et al. 2021). Following the extended educational disruptions, it remains to be examined which gender group experienced greater uncertainty regarding career planning and how SES background affected adolescents' ability to navigate technological and socioeconomic turbulence in sustaining career goals. Given these nuanced differences, exploring the impacts of VUCA on adolescents' career decision-making requires a contextual analysis moderated by personal background.

Drawing upon SCCT, contextual factors operate at both distal and proximal levels to shape adolescents' career expectations. In the present study, the examination of the VUCA environment encompasses two facets: the unpredictable labour market (a distal influence, including economic conditions and pandemic measures) and prolonged education disruption (a proximal influence,

including school closures and the lack of career guidance during the pandemic).

Educational disruption caused by school closures directly constrains students' capacity to formulate decisive career expectations (Jemini-Gashi and Kadriu, 2022). Despite evidence suggesting that school closures effectively mitigate viral transmission, the experience of unexpected school closures has been associated with heightened feelings of isolation and anxiety among young people (Alfano, 2022; Chaabane et al. 2021). Donohue and Miller (2020) observed that school closures have resulted in profound academic, health, and economic consequences that may persist into students' adulthood. However, limited research has addressed the influence of school closures on students' occupational aspirations. The abrupt shift to remote learning and reduced social interactions has led to significant learning losses and mental health challenges (Jack and Oster, 2023). As a result, prolonged school closures have exacerbated the VUCA situation, adding difficulties for adolescents in making informed career decisions, particularly among low-achieving students who may have hesitated about their career expectations before the pandemic (Sabates et al. 2017).

Furthermore, socioeconomically disadvantaged students face greater uncertainty regarding their career expectations and are more vulnerable to educational disruptions (Greve et al. 2021; Jack and Oster, 2023). The transition to online learning places greater reliance on family support and digital resources, exacerbating existing digital and socioeconomic divides, particularly in high-income countries (Goudeau et al. 2021). Such relative social deprivation may lead lower SES students to perceive greater barriers to their future career opportunities in wealthy economies. Social comparison significantly affects individual self-appraisal (e.g., self-concept and self-efficacy), resulting in divergent interests and goals (Marsh et al. 2020; Vrugt and Koenis, 2002). Therefore, this study examines whether disadvantaged backgrounds heightened adolescents' career indecision in higher-income countries due to social comparison processes.

NEET and career expectation uncertainty. Adolescents' career indecisiveness is also influenced by distal contexts, such as economic development conditions, unemployment rates, and national measures in coping with the pandemic. Among these, NEET is particularly significant in shaping young people's career decision-making. NEET measures the proportion of youth (ages 15–24) who are outside of education, employment, or training for six months or more, reflecting the challenges they encounter during the school-to-work transition (Bynner and Parsons, 2002). This indicator has garnered significant attention for its potential to address early school dropout, youth vulnerability, and unemployment, aligning with Sustainable Development Goal 8's objectives to foster inclusive and sustainable economic growth and full employment (Schoon, 2020). However, the disruptive impacts of the pandemic have exacerbated this issue, leading to a notable increase in NEET rates, with one in four youths classified as NEET in 2022 (United Nations, 2023).

Moreover, gender discrepancies have become apparent, with girls being more than twice as likely as boys to fall into the NEET category, particularly in lower- and middle-income countries (United Nations, 2023). Amidst social and economic crises, the confluence of a sharp decline in family income and the transition to online learning has widened discrepancies in accessing education and employment, contributing to the enlarged gender achievement gaps (Dasgupta, 2022). Studies have found that young men's NEET status is primarily attributed to poor labour market experiences, while young women's NEET status is closely

related to child-rearing responsibilities and poor psychological well-being (Bynner and Parsons, 2002). The association between NEET status and career expectation uncertainty requires further investigation across gender groups.

Empirical research has demonstrated that adolescents' uncertain and misaligned occupational aspirations predict their NEET status at age 18, particularly among the disadvantaged (Yates et al. 2011). Students who are unsure about their educational and occupational plans during secondary school are much more likely to fall into NEET during emerging adulthood. Meanwhile, increased unemployment rates among youth and unstable economic conditions discourage adolescents from pursuing decisive career goals and committing to a dedicated career path from adolescence onward. NEET rates, which reflect the problematic school-to-work transitions of youth, should be considered a crucial distal context influencing adolescents' career decision-making. However, whether this influence is stronger among disadvantaged youth remains to be explored.

The present study. Educational disruptions and technological advancements have disproportionately impacted youth, particularly girls, younger cohorts, and those from lower-income countries (ILO, 2020). Guided by SCCT, this study examines cross-country variations in adolescents' career expectation uncertainty by integrating individual, school, and national-level factors. Specifically, we explore how national development indicators (e.g., GDP, youth NEET rates), pandemic-related measures (e.g., stringency, working-hour losses), school contexts (e.g., school closures, career guidance), and student characteristics (e.g., gender, family background, ability, self-efficacy, and preparedness for uncertainty) influence career expectation uncertainty. By examining the influence of proximal and distal environmental factors, the present study provides a comprehensive understanding of how structural and psychological mechanisms shape youth career expectation uncertainty across diverse socioeconomic contexts.

Leveraging the most recent PISA 2022 data, alongside other scholarly and administrative datasets, this study formulates the following hypotheses:

H1: Higher national NEET rates are positively associated with career expectation uncertainty, as economic constraints may shape students' outcome expectations, reducing confidence in their ability to achieve career goals.

H2: Greater educational disruptions (e.g., extended school closures) predict higher career expectation uncertainty, as a lack of structural support limits students' ability to develop career-related self-efficacy.

H3: Higher levels of career guidance at the school level are associated with lower career expectation uncertainty, as SCCT posits that contextual support enhances self-efficacy and goal-setting.

H4a: The relationship between economic conditions (e.g., GDP per capita, NEET rates) and career expectation uncertainty is moderated by students' **SES** background, with disadvantaged students experiencing greater uncertainty due to fewer contextual affordances.

H4b: The relationship between economic conditions (e.g., GDP per capita, NEET rates) and career expectation uncertainty is moderated by **gender**, with girls experiencing greater uncertainty due to gendered social expectations and career barriers.

Method
Participants. PISA is a triennial international survey conducted by the Organisation for Economic Co-operation and Development (OECD) to assess the competencies of 15-year-olds in reading, mathematics, and science. Each testing cycle employs a two-stage Probability Proportionate to Size Sampling method to collect data on students' backgrounds, attitudes, and dispositions toward learning across various educational systems. The data collection process adhered to appropriate guidelines and regulations, with informed consent obtained from all participants and their legal guardians. The Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong has granted ethical approval for this research under reference No. SBRE-23-0067. This study analysed data from 80 economies that participated in the PISA 2022 cycle. Proper sampling weights were applied to ensure the generalisability of the results to the broader population of 15-year-olds in these economies.

Country-level metrics were sourced from multiple academic and administrative databases to ensure methodological consistency and comparability. Data on NEET rates, the Stringency Index, GDP per capita, and working-hour losses were obtained from the International Labour Organisation (ILO), the Oxford COVID-19 Government Response Tracker (OxCGRT), and the World Bank, respectively. All data were extracted for the same year as PISA 2022 to ensure temporal alignment. In cases where 2022 data were unavailable, values from the nearest available year were used to maintain consistency. Sensitivity analyses were conducted to minimise the potential biases introduced by using the nearest available year. Moreover, to reconcile differences in data collection methodologies across sources, all variables were collected at the country level. Where definitions varied across datasets (e.g., age groups in NEET classifications), internationally recognised standards were prioritised, facilitating robust cross-national comparisons.

Measures
Career expectation uncertainty. The dependent variable was derived from students' responses to the open-ended question, "What do you expect to do at your 30 years old?" Responses were coded using the International Standard Classification of Occupations 2008 edition (ISCO-08). Consistent with previous research (Greve et al. 2021; Sikora, 2018), students who responded with "Housework" (ISCO-08: 9701), "Retired" (9703), "Don't know" (9704), vague answers like "A good job" or "A well-paid job" (9705), and no responses were classified as career expectation uncertainty.

Student background
SES: It was measured using the economic, social, and cultural status index provided in the PISA dataset. This index was derived from principal component analysis of parental education level, parental occupational status, and family possessions (as proxies for family income). The scores were standardised across OECD countries.

Preparedness for uncertainty: This was measured by a 4-point Likert scale item evaluating students' readiness for future school closures: "Overall, how prepared do you feel for learning on your own if school buildings were to close again for an extended period in the future?" Higher scores indicated greater preparedness.

Self-efficacy in self-directed learning: Self-efficacy was assessed through an 8-item, 4-point Likert scale, including statements such as "I am confident in planning when to do my schoolwork on my own" and "I am confident in motivating myself to do school work" (Cronbach's $\alpha = 0.901$). Higher scores indicated greater self-efficacy in self-directed learning.

Moreover, students' **gender** (Female = 1; Male = 0) and **academic achievement** (averaged scores across math, reading,

and science, using ten plausible values for each domain) were also included in the analysis.

School context
School closure: Students responded to a pandemic-specific questionnaire asking, "In the last 3 years, did your school close due to COVID-19?" Responses ranged from 1 = not at all to 6 = more than 12 months. These responses were averaged within each school to estimate the length of school closures.

Career guidance: This was collected from school principals asking whether schools provide career guidance services to students.

Meanwhile, students' academic achievement and SES were aggregated to the school level to represent **school achievement and school SES**.

Country-level indicators
NEET rate: This index quantifies the proportion of individuals aged 15–24 who are not engaged in education, employment, or training relative to the total population of the same age group in an economy (ILO, 2024).

Stringency index: Sourced from the OxCGRT project, the index is derived from the average score of nine metrics, including mandates like stay-at-home orders, public gathering restrictions, and public transport closures (Hale et al. 2021).

In addition, **GDP** per capita and **working-hour losses** due to the pandemic were also obtained for the year 2022.

Data analyses. Data preparation was conducted using SPSS (version 29), including multiple imputation of missing data in the independent variables (less than 10%; Rubin, 2004) and computation of correlations and descriptive statistics. All variables were standardised across the whole sample before multilevel analyses to ensure comparability of coefficients. A global map illustrating the varying degrees of adolescents' career expectation uncertainty was generated using ArcGIS software.

Multilevel generalised linear model. Two-level generalised linear models (GLMs) with logistic links were employed using Mplus 8.8 (Muthén and Muthén, 2019) to analyse the impact of proximal environmental factors (school contexts) and personal factors (student characteristics). Additionally, three-level GLMs with probit links were used to examine distal contexts while controlling for proximal school- and student-level factors. Standardised coefficients were calculated and converted to predicted probabilities to facilitate interpretation (McCabe et al. 2021). Sample weights were applied at both student and school levels, ensuring equitable representation across economies in the analysis.

Specifically, probit links relate the predictors to the outcome through the standard normal cumulative distribution function $\Phi(.)$. The binary response $Y_{ijk} = 1$ occurs when it exceeds a threshold γ (i.e., $P(y_{ijk} = 1) = P(y_{ijk} > \gamma)$.). Hence, for student k in school j in economy i, the three-level probit regression models can be written as (Gibbons and Hedeker, 1997):

$$y_{ijk} = \beta_{0i} + x'_{ijk}\beta_{ij} + w'_{ijk}\alpha + \varepsilon_{ijk}$$

where β_{ij} represents random effects and w_{ijk} represents covariates. The errors at different levels are assumed to be normally distributed. Accordingly, the probability that $y_{ijk} = 1$ (students expect to be scientists in this study), conditional on β^* and α, is

given by:

$$P\left(y_{ijk} = 1|\beta^*, \alpha\right) = (2\pi\sigma_\varepsilon^2)^{-1/2} \int_\gamma^\infty \exp\left[-\tfrac{1}{2\sigma_\varepsilon^2}(y_{ijk} - \beta_{0i} - x'_{ijk}\beta_{ij} - w'_{ijk}\alpha)^2\right] dy$$
$$= \Phi[-(\gamma - \beta_{0i} - x'_{ijk}\beta_{ij} - w'_{ijk}\alpha)/\sigma_\varepsilon],$$

To ensure model identifiability, $\gamma = 0$ and $\sigma_\varepsilon = 1$ were set. A one-unit change in x_{ijk} leads to a β_{ij}-unit change in the Z-score associated with predicted probability (McNeish et al. 2023).

The analysis proceeded as follows: first, two-level logistic models examined the impact of proximal school environments (school closure and career guidance) and student background (gender, SES, ability, self-efficacy, and preparedness for uncertainty) on adolescents' career expectation uncertainty. Next, three-level probit models were employed to account for distal contexts (GDP, NEET rates, stringency index, and working-hour losses) while controlling for lower-level covariates. Finally, cross-level interactions were included to explore potential moderation effects between environmental and personal background factors.

Results
The proportion of adolescents encountering uncertainty about their career expectations almost doubled from 2018 ($\mu = 22.86$, $SD = 9.20$) to 2022 ($\mu = 39.92$, $SD = 11.60$). Figure 1 depicts the distribution of adolescents expressing career indecisiveness across 80 countries, with red circles indicating above-average levels and blue indicating below-average. The severity of youth career indecision did not resemble economic development status. Specifically, Azerbaijan (77.8%) and Belgium (75.8%) recorded the highest percentages of students unsure about their career choices at age 30, whereas Turkey (19.6%), Vietnam (20.4%), and Singapore (21.2%) had the lowest.

Figure 2 demonstrates the change in adolescents' career expectation uncertainty following the pandemic, which was most pronounced in developing economies. For instance, Azerbaijan saw the greatest increase (48%), followed by Albania (39.7%), while Chinese Taipei (−0.3%) and Australia (−0.1%) effectively mitigated this uncertainty among their youth.

GLMs further investigated the influence of proximal and distal environments on adolescents' career decision-making (see descriptive statistics in Table 1). Overall, better academic achievement at both student and school levels was associated with greater clarity in students' career expectations. Boys, students from lower-SES backgrounds, and those with limited preparation for uncertainty and lower self-efficacy were more prone to career expectation uncertainty. Contrary to our expectations, extended education disruptions (school closure) were related to less confusion in students' career decision-making ($\beta_{Edu\ disrupt} = -0.125$, $p < 0.001$; Table 2). Notably, career guidance played a crucial role in clarifying career decisions, particularly for adolescent girls ($\beta_{Female*Career\ guide} = -0.005$, $p < 0.05$).

When considering country-level indicators, distal contexts explained approximately 65% of the variance in adolescents' career expectation uncertainty, whereas proximal and personal factors accounted for only about 10% (Table 3). Youth career indecisiveness persisted in some economies ($\beta_{Stability} = 0.799$, $p < 0.001$; Model 1). National NEET rates partially contributed to students' career indecision ($\beta_{NEET} = 0.094$, $p < 0.05$; Model 3), although this influence was not consistently significant across all models.

Contrary to expectations, cross-level moderation effects revealed that higher SES students were more uncertain about their career expectations in high-income countries ($\beta_{SES*GDP} = 0.012$, $p < 0.001$; Model 4 in Table 3). However, socioeconomically disadvantaged students were more affected by youth NEET ($\beta_{SES*NEET} = -0.010$, $p < 0.001$; Model 5). Regarding
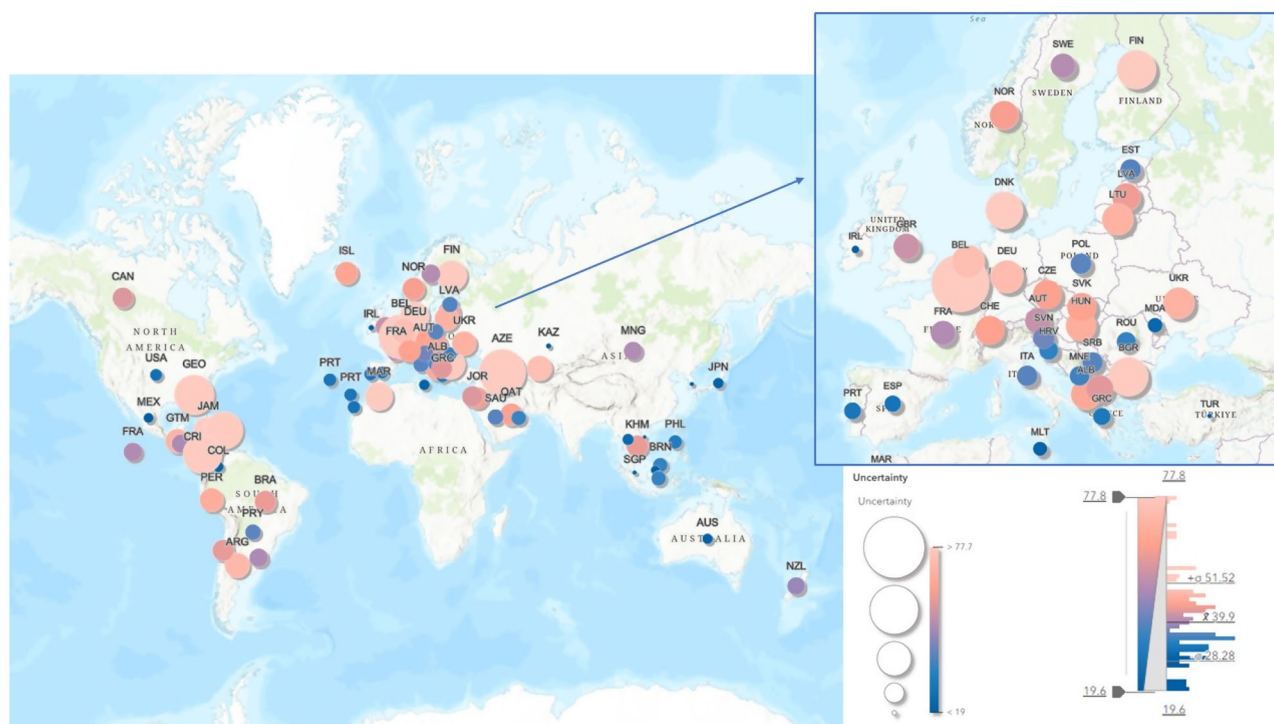
Fig. 1 Proportions of adolescents experiencing career expectation uncertainty in 2022. Larger circles in the ArcGIS Online basemap indicate higher percentages of uncertainty.

gender differences, girls exhibited slightly more indecisiveness in wealthier nations ($\beta_{Female*GDP} = 0.003$, $p < 0.05$; Model 6). The NEET environment did not disproportionately affect boys' and girls' career planning.

Discussion

In an increasingly VUCA world, intensified by technological advancements and educational disruptions, adolescents face growing challenges in career decision-making due to conflicting information and labour market unpredictability. This study utilised PISA 2022 data and multilevel GLMs to examine how distal and proximal environmental factors shape career expectation uncertainty among 15-year-olds across 80 economies. The findings showed that: (a) the proportion of adolescents experiencing career indecision nearly doubled post-pandemic and remained persistent in some economies; (b) country-level factors accounted for 65% of the variance in career expectation uncertainty, while school- and individual-level factors explained only 10%; (c) students with lower self-efficacy and inadequate future preparation were more prone to career indecision; (d) educational disruptions had no significant impact on career decision-making, though career guidance was particularly beneficial for girls; and (e) youth NEET status contributed to career expectation uncertainty, with a stronger effect on disadvantaged students.

Prevalence of career expectation uncertainty. According to SCCT, environmental factors play a substantial role in shaping cognitive-personal variables and individual career choices (Lent et al. 2000). In the wake of a VUCA world, the average percentage of adolescents experiencing career indecision nearly doubled from 2018 to 2022, with boys being dominant. This significant increase can be attributed to the widespread social and digital disruptions caused by the pandemic and the rapid advancement of AI. Adolescents, who are at a crucial stage of identity formation and career planning, are particularly vulnerable to these

environmental challenges (Branje et al. 2021). The prevailing health crisis has led to significant educational and health losses (Donohue and Miller, 2020), and the proliferation of fragmented and unreliable information has further complicated the process of making informed and rational decisions regarding educational and occupational choices (Swire-Thompson and Lazer, 2020). Consequently, the harsh VUCA environment has hindered adolescents' career decision-making and heightened uncertainty.

Interestingly, the persistence of career expectation uncertainty was observed in economies where a higher proportion of adolescents already exhibited hesitation about their career choices in 2018. This cross-temporal consistency explains 60% of the variance in youth career indecision at the country level and may be attributable to inadequate national career guidance and counselling practices. As Lam and Tang (2021) argue, graduate employability is shaped by both contextual factors and individuals' subjective interpretations and experiences. The compounded effects of limited career guidance and pandemic-induced learning losses could lead to severe educational and occupational deficits (Jemini-Gashi and Kadriu, 2022). Given the long-term negative consequences of adolescent career indecision on social and economic outcomes (Greve et al. 2021), targeted interventions are urgently needed, particularly for disadvantaged students, boys, and those with low self-efficacy and inadequate psychological readiness for uncertainty.

Although adolescents in less-developed countries have borne the brunt of educational and occupational losses during the pandemic (ILO, 2020), career expectation uncertainty did not systematically differ between economically developed and developing regions. Some high-income economies, such as Chinese Taipei and Australia, effectively mitigated career indecision, possibly due to strong career guidance programmes and stable labour markets. In contrast, others, like Switzerland and Finland, experienced significant increases in career uncertainty, which may reflect shifts in labour market demands and changing career aspirations. Similarly, in developing economies, Azerbaijan and
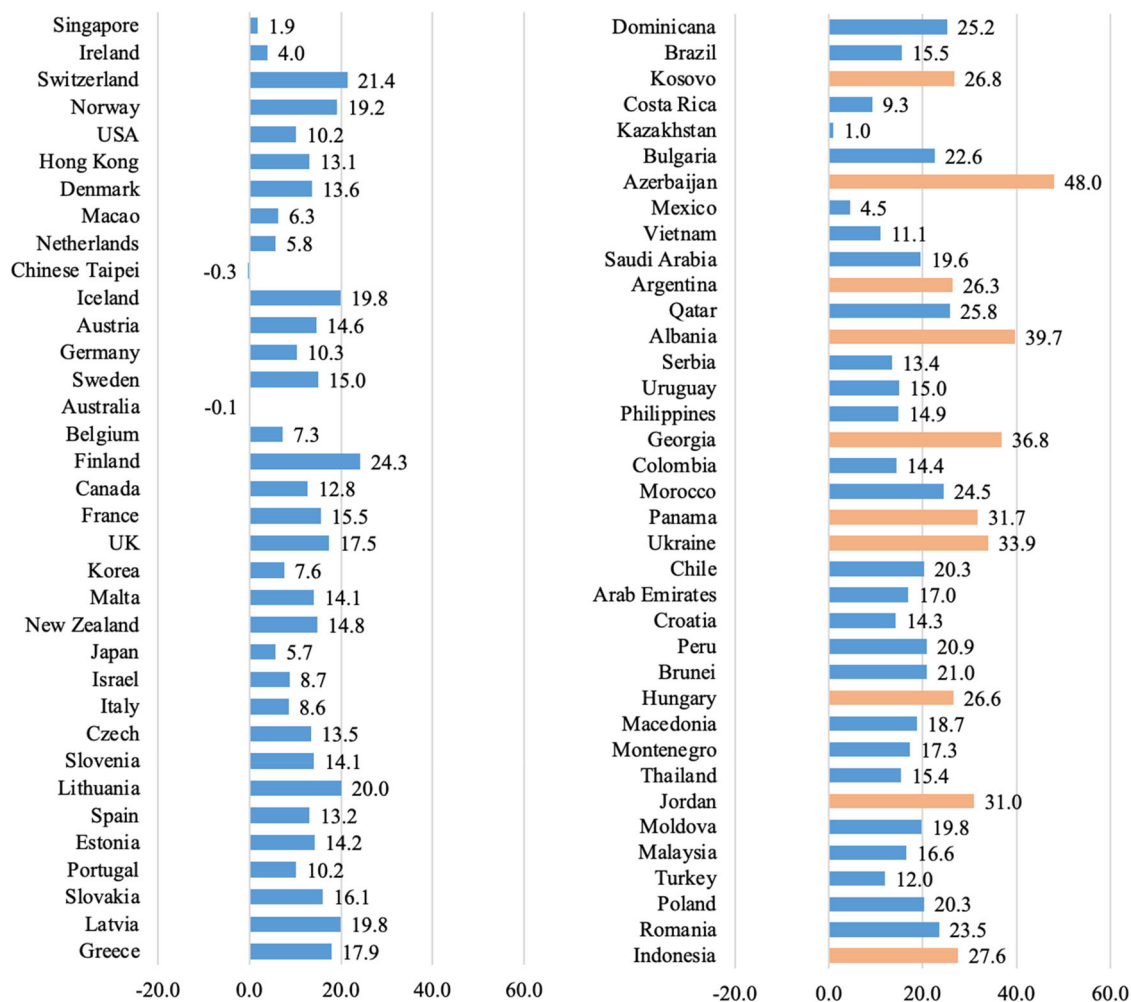
Fig. 2 Increase in the proportions of adolescents experiencing career expectation uncertainty from 2018 to 2022. Economies are ordered by GDP per capita (top-down from left to right). Orange colour = change is larger than one standard deviation.

Albania saw heightened career expectation uncertainty post-pandemic, while Turkey and Vietnam remained relatively stable, likely influenced by economic recovery and career education policies. These findings underscore the complex and context-dependent nature of career uncertainty, emphasising the importance of effective career exploration and educational identity formation during early-to-middle adolescence (Negru-Subtirica and Pop, 2018). However, the substantial increases in youth career indecision after the pandemic and the wide variation of adolescents uncertain about their future careers across 80 economies (19.6% to 77.8%) warrant further investigation.

Impact of distal environment. The findings highlight that societal-level factors significantly contribute to adolescents' career indecision, more so than proximal and individual factors. Distal environments are particularly influential as they shape career interests and perceptions of opportunities for success (Lent et al. 2000). Among these factors, youth NEET rates, which reflect the labour market challenges faced by young people, were significantly associated with adolescents' career indecision, irrespective of gender. Previous studies have shown that students with uncertain and misaligned career aspirations at age 16 are more likely to become NEET two years later (Yates et al. 2011). As a distal context, the NEET environment negatively influences adolescents' perceptions of future employment opportunities, thereby hindering their career decision-making.

Moreover, this negative influence was particularly pronounced among disadvantaged adolescents. Distal environmental barriers actively obstruct personal career interests and choices, yet they are often overlooked in academic research (Sheu and Bordon, 2017). NEET rates, indicating youth inactivity and social exclusion in a VUCA world, profoundly shape adolescents' perceptions of the job market and social mobility opportunities. Students from lower SES backgrounds may perceive fewer career opportunities, leading to disengagement from their goals and increasing uncertainty about their occupational expectations (Schoon and Heckhausen, 2019). The social and digital divides have exacerbated learning and health losses for lower SES students (Greve et al. 2021). Given the adverse outcomes associated with uncertain career expectations during middle adolescence, targeted career guidance is crucial to mitigating these detrimental effects.

Contrary to our hypothesis, higher SES students, particularly girls in high-income countries, exhibited greater career indecision, suggesting an overabundance of choices. Research indicates that girls from privileged families often hold less instrumental motivation (i.e., considering economic returns) when forming career aspirations and may be more inclined to explore gendered self-expression (Liu, 2020). As a result, adolescent girls in developed and postindustrial countries may perceive a wide array of career choices and feel less urgent in making a definitive career decision, preferring to fully explore their options. The

Table 1 Correlations and descriptive statistics of uncertain career expectations, national environments, school contexts, and student background factors.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Mean	S.D.
1. Uncertain2018	—														22.86	9.2
2. GDP	0.29	—													4.55	0.3
3. NEET	−0.31	−0.72	—												14.04	6.87
4. Stringency	−0.21	−0.06	0.08	—											22.53	11.54
5. Work-hour loss	−0.16	−0.20	0.06	0.08	—										0.3	3.54
6. Sch achievement	0.18	0.55	−0.54	−0.07	−0.14	—									443.13	74.06
7. Sch SES	0.24	0.61	−0.50	−0.15	−0.13	0.73	—								−0.32	0.76
8. Edu disruption	−0.06	−0.10	0.16	0.03	0.05	0.04	0.04	—							3.5	0.59
9. Career guidance	−0.06	0.08	−0.10	0.05	0.10	0.07	0.08	−0.05	—						0.85	0.36
10. Gender	0.00	−0.02	0.02	0.00	0.00	0.04	0.01	0.03	0.00	—					0.5	0.5
11. SES	0.16	0.41	−0.34	−0.10	−0.09	0.49	0.67	0.03	0.05	−0.02	—				−0.32	1.13
12. Achievement	0.13	0.42	−0.41	−0.05	−0.11	0.76	0.55	0.03	0.05	0.04	0.47	—			443.13	97.56
13. Preparation	0.03	0.08	−0.08	−0.04	0.01	0.11	0.14	−0.01	0.01	−0.05	0.16	0.14	—		2.65	0.88
14. Self-efficacy	−0.01	0.05	−0.03	−0.02	0.01	0.10	0.12	0.06	0.01	0.02	0.15	0.15	0.39	—	−0.04	0.99
15. Uncertain2022	0.16	−0.03	0.04	−0.03	0.00	−0.13	−0.06	−0.05	−0.03	−0.07	−0.07	−0.17	−0.05	−0.07		

S.D. standard deviation, *Uncertain* uncertain career expectations, *GDP* gross domestic product per capita, *NEET* not in education, employment, or training, *Sch* school, *Edu* education, *SES* socioeconomic status.

Table 2 Standardised coefficients in two-level logistic regressions predicting uncertain career expectations with school contexts and student background factors.

	M1		M2		M3		M4		M5		M6		M7	
	β	Pr	β	Pr	β	Pr	β	Pr	β	Pr	β	Pr	β	Pr
School context														
School achievement	−0.204[c]	0.45	−0.199[c]	0.45	−0.171[c]	0.46	−0.171[c]	0.46	−0.171[c]	0.46	−0.171[c]	0.46	−0.171[c]	0.46
School SES	−0.262[c]	0.43	0.263c	0.57	0.270[c]	0.57	0.270[c]	0.57	0.270[c]	0.57	0.270[c]	0.57	0.270[c]	0.57
Edu disruption			−0.125[c]	0.47	−0.125[c]	0.47	−0.125[c]	0.47	−0.125[c]	0.47	−0.125[c]	0.47	−0.125[c]	0.47
Career guidance					−0.076[c]	0.48	−0.076[c]	0.48	−0.077[c]	0.48	−0.076[c]	0.48	−0.076[c]	0.48
R^2 within	0.031		0.047		0.052		0.052		0.052		0.052		0.052	
Student background														
Female gender	−0.074[c]	0.48	−0.073[c]	0.48	−0.073[c]	0.48	−0.073[c]	0.48	−0.073[c]	0.48	−0.073[c]	0.48	−0.073[c]	0.48
SES	−0.038[c]	0.49	−0.038[c]	0.49	−0.037[c]	0.49	−0.037[c]	0.49	−0.037[c]	0.49	−0.037[c]	0.49	−0.037[c]	0.49
Achievement	−0.186[c]	0.45	−0.186[c]	0.45	−0.189[c]	0.45	−0.189[c]	0.45	−0.189[c]	0.45	−0.189[c]	0.45	−0.189[c]	0.45
Preparation	−0.032[c]	0.49	−0.032[c]	0.49	−0.033[c]	0.49	−0.033[c]	0.49	−0.033[c]	0.49	−0.033[c]	0.49	−0.033[c]	0.49
Self-efficacy	−0.029[c]	0.49	−0.028[c]	0.49	−0.027[c]	0.49	−0.027[c]	0.49	−0.027[c]	0.49	−0.027[c]	0.49	−0.027[c]	0.49
Interactions														
SES*Edu disrupt							−0.001	0.50						
SES*Career guide									−0.002	0.50				
Female* Edu disrupt											−0.002	0.50		
Female* Career guide													−0.005[a]	0.50
R^2 between	0.055				0.055	0.056		0.056		0.056		0.056	0.056	

[a]$p < 0.05$, [b]$p < 0.01$, [c]$p < 0.001$;
Pr predicted probability, *SES* Socioeconomic status *Edu* Education.

affluent family resources and favourable national economic conditions in these countries may reduce environmental barriers to delayed career planning, allowing for an extended period of career exploration without economic constraints.

Impact of proximal environment. This study showed that extended educational disruptions caused by school closures did not significantly increase career indecision among adolescents, contrasting with the expected outcomes based on the broader literature on the negative impacts of school closures. Existing research has primarily focused on the detrimental effects of school closures on academic achievement, mental health, and economic consequences (Donohue and Miller, 2020), yet few have examined their impact on adolescents' career decision-making. The relationship between school closures and career indecision can be more complex.

One possible explanation is that the forced shift to remote learning and the increased reliance on digital tools may have inadvertently fostered greater autonomy and self-directed learning among students, which are critical components of career decision-making (Zimmerman, 2002). Students who adapted well to remote learning may have developed stronger self-regulation skills and a sense of agency, which could have helped mitigate the uncertainty in their career expectations. Moreover, research has shown that adolescents with higher self-efficacy in self-directed learning are better equipped to cope with environmental changes and are more likely to engage in proactive career planning (Morris, 2019).

Another factor that could explain the limited impact of school closures on career indecision is parental involvement. During the pandemic, many parents took on a more active role in their children's education, providing support and guidance that may

Table 3 Standardised coefficients in three-level probit regressions predicting uncertain career expectations with national environments, school contexts, and student background factors.

		M1 β	M1 Pr	M2 β	M2 Pr	M3 β	M3 Pr	M4 β	M4 Pr	M5 β	M5 Pr	M6 β	M6 Pr	M7 β	M7 Pr	M8 β	M8 Pr
CNT level	**Stability**																
	Uncertainty 2018	0.799c	0.79	0.821c	0.79	0.824c	0.80	0.810c	0.79	0.812c	0.79	0.814c	0.79	0.814c	0.79		
	National environment																
	GDP			−0.010	0.50	0.018	0.51	0.033	0.51	0.021	0.51	0.026	0.51	0.026	0.51	0.139	0.56
	NEET			0.082	0.53	0.094a	0.54	0.083	0.53	0.072	0.53	0.082	0.53	0.082	0.53	−0.060	0.48
	Pandemic influence																
	Stringency					−0.002	0.50	−0.002	0.50	−0.002	0.50	−0.001	0.50	−0.001	0.50	−0.136	0.45
	Work-hour loss					0.087	0.53	0.077	0.53	0.079	0.53	0.079	0.53	0.079	0.53	0.026	0.51
	R^2 between cnt	0.639		0.643		0.655		0.647		0.649		0.649		0.649		0.079	
SCH level	**School context**																
	Sch achievement	−0.208c	0.42	−0.206c	0.42	−0.206c	0.42	−0.213c	0.42	−0.213c	0.42	−0.208c	0.42	−0.208c	0.42	−0.212c	0.42
	Sch SES	0.184c	0.57	0.176c	0.57	0.177c	0.57	0.183c	0.57	0.181c	0.57	0.175c	0.57	0.175c	0.57	0.187c	0.57
	Edu disruption	−0.154c	0.44	−0.150c	0.44	−0.151c	0.44	−0.156c	0.44	−0.157c	0.44	−0.157c	0.44	−0.157c	0.44	−0.157c	0.44
	Career guidance	−0.045c	0.48	−0.041c	0.48	−0.045c	0.48	−0.042c	0.48	−0.043c	0.48	−0.043c	0.48	−0.043c	0.48	0.044c	0.52
	R^2 between sch	0.047		0.046		0.047		0.049		0.049		0.048		0.048		0.049	
STU level	**Student background**																
	Female gender	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47	−0.080c	0.47
	Achievement	−0.205c	0.42	−0.205c	0.42	−0.205c	0.42	−0.205c	0.42	−0.205c	0.42	−0.204c	0.42	−0.204c	0.42	−0.204c	0.42
	SES	−0.041c	0.48	−0.040c	0.48	−0.039c	0.48	−0.037c	0.48	−0.037c	0.48	−0.039c	0.48	−0.039c	0.48	−0.038c	0.48
	Preparation	−0.036c	0.49	−0.036c	0.49	−0.036c	0.49	−0.037c	0.49	−0.037c	0.49	−0.037c	0.49	−0.037c	0.49	−0.036c	0.49
	Self-efficacy	−0.029c	0.49	−0.028c	0.49	−0.028c	0.49	−0.028c	0.49	−0.028c	0.49	−0.028c	0.49	−0.028c	0.49	−0.029c	0.49
	Interactions																
	SES*GDP							0.012c	0.50							0.008c	0.50
	SES* NEET									−0.010c	0.50					−0.004	0.50
	Female* GDP											0.003a	0.50			0.006c	0.50
	Female*NEET													0.000	0.50	0.004	0.50
	R^2 within	0.066		0.066		0.066		0.066		0.066		0.065		0.065		0.066	

a $p < 0.05$; b $p < 0.01$; c $p < 0.001$.

Pr predicted probability; GDP gross domestic product per capita, NEET Not in Education, Employment, or Training; SES socioeconomic status, CNT country, SCH school, STU student, Edu education.

have compensated for the lack of in-person schooling (Lee et al. 2021). This increased parental involvement may have helped maintain stability in students' educational and career aspirations, even in the face of disrupted schooling.

Furthermore, the study highlights the critical role of career guidance in reducing career indecision, particularly for girls. While previous research has documented the benefits of career counselling in helping students navigate educational and occupational choices (Perdrix et al. 2012), this study underscores the importance of targeted career guidance interventions in mitigating the effects of environmental disruptions. Career guidance not only provides students with information about different career paths but also helps them align their aspirations with their strengths and interests, thereby reducing uncertainty. For girls, who may face additional barriers due to gender stereotypes and biases, such guidance is particularly crucial in fostering confidence and ambition in career planning (Wang and Degol, 2017).

Limitations. Several limitations should be acknowledged in this study. Firstly, the cross-sectional design restricts our ability to draw causal inferences between the variables examined. To gain a more comprehensive understanding of how career expectation uncertainty evolves over time, longitudinal studies within specific countries would be more effective. Secondly, while this study focuses on uncertainty within the VUCA framework, other aspects of VUCA—such as volatility in labour markets, complexity in career pathways, and ambiguity in future job demands—may also shape adolescents' career expectations and warrant further exploration. Additionally, while SCCT provides a strong framework for examining self-efficacy, outcome expectations, and contextual factors, it does not fully account for adaptability in career decision-making, as emphasised in Career Construction Theory, or social constraints, as highlighted in the Theory of Circumscription and Compromise. Future research could integrate these perspectives for a more comprehensive understanding of adolescent career uncertainty. Lastly, although this study

examines societal and school influences, other context-specific factors, such as parental involvement and peer dynamics, may also play a critical role in shaping students' career expectations.

Conclusions

In the VUCA era, distal contextual factors, such as national economic conditions and youth NEET rates, were found to exert a more substantial influence on the uncertainty surrounding adolescents' career expectations than proximal and individual-level factors. The study demonstrates that the proportion of adolescents experiencing career indecision doubled following the pandemic, with this heightened uncertainty persisting in certain economies. Importantly, the increase in career indecision was not disproportionately concentrated in lower-income countries; instead, higher youth NEET rates emerged as a significant predictor of challenges in career decision-making, particularly among disadvantaged students.

Proximal environmental factors, such as educational disruptions, did not significantly affect adolescents' career decision-making processes. However, the study indicates that girls derived greater benefits from targeted career guidance, which was crucial in clarifying and promoting their career expectations. Since career indecision has more profound long-term consequences for disadvantaged students, this study underscores the critical need to address the escalating uncertainty in career expectations. Targeted interventions should be developed to address the specific needs of girls and students from lower SES backgrounds, thereby mitigating the adverse effects of career indecision on their future occupational outcomes.

Data availability

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Author contributions

LG was responsible for the conceptualisation, data analysis, preparation of graphs and tables, manuscript drafting, and review. All authors reviewed the final manuscript and approved its submission for publication.

Competing interests

The author declares no competing interests.

Ethical approval

This study was approved by the Survey and Behavioural Research Ethics Committee (SBREC) of The Chinese University of Hong Kong (Approval No. SBRE-23-0067) on 10 March 2022. The research involved human participants and was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki and all applicable institutional and national guidelines and regulations.

Informed consent

Written informed consent was obtained from the legal guardians of all student participants prior to the PISA 2022 data collection in April 2022. The process was conducted by trained personnel under the supervision of the research team at The Chinese University of Hong Kong and followed the procedures approved by the Survey and Behavioural Research Ethics Committee. Guardians received written information about the study's purpose, voluntary participation, procedures, and data use. Consent covered participation, use of anonymised data for research, and publication of aggregated results. Anonymity and confidentiality were assured in accordance with ethical guidelines and data protection regulations.

Additional information

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