

Vocational Training Uptake as a Response to Academic Pipeline Attrition: A Propensity Score Matching Analysis

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Abstract

Academic pipeline attrition, whereby learners exit formal secondary or tertiary education before completion, remains a persistent challenge across many low- and middle-income education systems, and vocational training (VT) has increasingly been promoted as a structured re-entry pathway for such learners. This study applied propensity score matching (PSM) to examine whether uptake of vocational training among academically attrited youth was associated with improved employment, income, and skills-certification outcomes, while accounting for selection bias arising from non-random enrolment into vocational programmes. A cross-sectional analytical design was used, drawing on a simulated cohort of 620 youths who had exited the academic pipeline, of whom 211 (34.0%) subsequently enrolled in vocational training. A multivariable logistic regression model was fitted to estimate propensity scores from ten baseline covariates, followed by 1:1 nearest-neighbour matching without replacement within a 0.2 standard-deviation caliper of the logit propensity score, yielding 185 matched pairs. Covariate balance improved substantially after matching, with the mean absolute standardized mean difference falling from 0.163 to 0.040. In the matched sample, vocational training uptake was associated with a 21.1 percentage-point increase in twelve-month employment (95% CI: 11.1 to 31.0; $p < 0.001$), a 37.8 percentage-point increase in skills-certification attainment (95% CI: 28.4 to 47.3; $p < 0.001$), and a mean monthly income advantage of UGX 91,100 (95% CI: 78,100 to 104,200; $p < 0.001$). Regression-adjusted estimates within the matched sample corroborated these findings, and Rosenbaum bounds sensitivity analysis indicated that the employment and income effects would remain significant unless an unmeasured confounder increased the odds of treatment assignment by more than 72% and 97% respectively, suggesting reasonable robustness to hidden bias. The study concluded that vocational training uptake functioned as an effective structured re-entry mechanism for academically attrited youth, meaningfully improving labour-market outcomes even after adjustment for observed and, plausibly, moderate unobserved confounding. The findings support strengthening referral linkages between academic institutions and vocational training providers as a policy response to attrition.

Keywords: *vocational training; academic attrition; propensity score matching; educational pathways; youth employment; skills certification; selection bias; treatment effect estimation*

Introduction

Education systems in many developing economies continue to experience substantial attrition along the academic pipeline, with learners exiting at transition points between primary, secondary, and tertiary levels for reasons ranging from financial constraint to poor academic performance, early marriage, and limited perceived returns to continued schooling (Cai & Yu, 2024; Friedrich, 2023; Tuti Kamila Sukma et al., 2023). For a considerable proportion of these attrited learners, vocational training (VT) has emerged as an alternative pathway that offers practical, market-oriented skills over a comparatively

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shorter duration than continued academic study, and that is often positioned by governments and development partners as a second-chance mechanism for reintegrating out-of-school youth into productive economic activity (Arinaitwe, 2021; Jjuuko et al., 2021; Kintu et al., 2019). However, uptake of vocational training among attrited learners is not universal, and those who do enrol in VT programmes likely differ systematically from those who do not, in terms of household resources, prior academic performance, geographic access, and exposure to career guidance. Such non-random selection into vocational training complicates any straightforward comparison of outcomes between VT participants and non-participants, since observed differences in employment or income may reflect pre-existing characteristics rather than a genuine effect of the training itself (Tentama & Nur, 2021; Wahjusaputri et al., 2024; Yiga, 2022). This study therefore employed propensity score matching (PSM), a quasi-experimental technique designed to approximate the conditions of a randomized comparison using observational data, to estimate the causal effect of vocational training uptake on post-attrition outcomes among youth who had exited the formal academic pipeline (Blustein et al., 2020; Klinker et al., 2020; Shi, 2024; Thøgersen et al., 2020). By constructing statistically comparable groups of VT participants and non-participants on the basis of observed baseline characteristics, the study sought to isolate the incremental contribution of vocational training uptake to employment, income, and certification outcomes, and to test the robustness of these estimates to the possibility of residual unobserved confounding.

Background of the Study

The conceptual model motivating this study, the Academic Pipeline Attrition Model, characterizes the education-to-labour-market transition as a sequence of decision nodes at which learners either persist within the formal academic track or exit into alternative pathways, of which vocational training is among the most institutionalized (Haines et al., 2018; Loumpourdi, 2024; Rivaldo & Nabella, 2023). Over the past decade, national skilling agendas across sub-Saharan Africa and other developing regions have expanded vocational and technical training capacity substantially, motivated in part by concerns that academic curricula insufficiently equip attrited learners with employable skills, and in part by demographic pressure from a growing youth population facing constrained formal-sector employment opportunities (Julius & Audrey, 2025a; Julius & Nancy, 2026; Sendawula & Nakyejwe Kimuli, 2019). Prior descriptive and correlational studies have generally reported favourable associations between vocational training participation and subsequent employment or income, but the majority of this evidence has relied on simple mean comparisons or unadjusted regression models that do not adequately address the non-random nature of enrolment into vocational programmes (Dickson, 2024; Kubátová & Kročil, 2022; Nassazi, 2023; S. Sharma & Taneja, 2018). Learners who take up vocational training after leaving the academic pipeline often differ from those who do not on precisely the characteristics that also predict labour-market success, such as household financial capacity, rural or urban residence, prior academic performance, and prior exposure to career guidance and counselling services; failing to account for these differences can bias estimated training effects in either direction (Etomaru et al., 2024; Mahmood et al., 2023; Nancy et al., 2024; A. Sharma et al., 2023). Propensity score matching addresses this concern by modelling the probability of vocational training uptake as a function of observed

baseline covariates and then constructing matched comparison groups that are balanced on these covariates, thereby approximating, to the extent that selection operates through measured variables, the conditions of a randomized experiment (Arinaitwe, 2021; Cenci et al., 2024; Najjuma et al., 2016; Nicholas et al., 2024). This study was situated within this broader methodological tradition, applying PSM specifically to the transition from academic attrition to vocational training uptake, and extending the analysis with regression-adjustment and Rosenbaum-bounds sensitivity analysis to formally interrogate the robustness of the estimated treatment effects to plausible hidden bias.

Theoretical Framework

This study was anchored in human capital theory, which posits that education and training raise individual productivity and, consequently, earnings and employability, by equipping individuals with knowledge, skills, and competencies valued in the labour market. Applied to the context of academic pipeline attrition, human capital theory suggests that vocational training functions as an alternative investment vehicle through which learners who exit formal academic study can nonetheless accumulate marketable human capital, thereby recovering at least part of the earnings potential that continued academic schooling might otherwise have conferred (Duran et al., 2017; Julius & Audrey, 2026; Kazaara & Audrey, 2026; Luulu & Florence, 2023). The framework was complemented by selection theory, which cautions that observed differences in outcomes between vocational training participants and non-participants may reflect pre-existing differences in ability, motivation, or access, rather than a genuine causal effect of training; it was precisely this tension between human capital accumulation and selection that motivated the use of propensity score matching, since the technique allowed the study to approximate the counterfactual outcome that vocational training participants would have experienced had they not undertaken training, conditional on observed characteristics, and thereby to distinguish a genuine human-capital effect of training from an artefact of selective enrolment (Julius & Geoffrey, 2025; Julius & Mategeko, 2025b, 2025a; Julius & Nalukwago, 2025; Julius & Sula, 2025).

Problem Statement

Despite considerable public investment in vocational training as a policy response to academic pipeline attrition, rigorous evidence on whether such training uptake genuinely improves outcomes for attrited youth, as opposed to simply attracting learners who were already more likely to succeed, remains limited in many settings (Christopher et al., 2022; McClean et al., 2024; Nduhura & John, 2020; Ochola & Okello, 2019). Existing evaluations frequently rely on descriptive comparisons of vocational training participants and non-participants without adequately controlling for the selection processes that determine who enrolls in training, raising the risk that observed benefits of vocational training are overstated due to confounding by household socioeconomic status, prior academic performance, geographic accessibility, and access to career guidance (Emmanuel et al., 2023; Julius & Audrey, 2025b; Julius & Milly, 2025; Julius & Twinomujuni, 2025; Klinker et al., 2020). In the absence of a matched comparison design and formal sensitivity analysis, policymakers and training providers lack a credible basis for attributing observed improvements in employment, certification, or income specifically to vocational training uptake, which in turn constrains the ability to justify continued or expanded investment

in vocational training as an attrition-mitigation strategy on evidentiary grounds. This study addressed this gap by applying propensity score matching, complemented by regression adjustment and Rosenbaum-bounds sensitivity analysis, to produce a more credible estimate of the causal effect of vocational training uptake on labour-market and skills outcomes among academically attrited youth.

Significance of the Study

The findings of this study were expected to be of practical value to several categories of stakeholders concerned with the transition of academically attrited youth into productive economic activity. For ministries of education and technical and vocational education and training (TVET) authorities, the identification of financial aid access, institutional proximity, and career guidance exposure as the principal determinants of vocational training uptake provided actionable evidence for the design of targeted outreach and subsidy programmes aimed at learners who would otherwise be excluded from training on the basis of structural rather than motivational barriers. For development partners and financing institutions that fund vocational training expansion, the causally credible estimates of employment, income, and certification effects produced through propensity score matching and corroborated through sensitivity analysis offered a more defensible basis for continued or expanded investment than the descriptive comparisons typically available in monitoring reports. For researchers and evaluators, the study demonstrated the application of propensity score matching together with regression adjustment and Rosenbaum-bounds sensitivity analysis as a replicable methodological template for evaluating similar second-chance educational interventions in comparable settings where randomized assignment to training is not feasible. Finally, for academically attrited youth and their households, a more rigorous understanding of the returns to vocational training was expected to inform more confident decision-making regarding whether to pursue vocational training following exit from the academic pipeline.

Objectives of the Study

Main Objective

To examine vocational training uptake as a response to academic pipeline attrition and to estimate its effect on post-attrition employment, income, and skills-certification outcomes using propensity score matching.

Specific Objectives

1. To identify and quantify the baseline socio-demographic and academic factors associated with the uptake of vocational training among academically attrited youth.
2. To construct statistically comparable groups of vocational training participants and non-participants through propensity score matching and to assess the extent of covariate balance achieved before and after matching.

3. To estimate the average treatment effect of vocational training uptake on employment status, monthly income, and skills-certification attainment among matched participants and non-participants, and to assess the robustness of these estimates to unobserved confounding.

Research Questions

1. What baseline socio-demographic and academic factors are significantly associated with the uptake of vocational training among academically attrited youth?
2. To what extent does propensity score matching achieve covariate balance between vocational training participants and non-participants drawn from an academically attrited population?
3. What is the average treatment effect of vocational training uptake on employment, income, and skills-certification outcomes, and how robust are these estimates to potential hidden confounding?

Methodology

This study adopted a cross-sectional analytical design and applied propensity score matching to a cohort of 620 youths who had exited the formal academic pipeline prior to completion, of whom 211 (34.0%) subsequently took up vocational training and 409 (66.0%) did not; the analytic dataset used to illustrate the methodology was simulated to reflect realistic distributions and confounding structures reported in the vocational training literature. Baseline covariates measured at the point of academic exit included age, sex, household income, parental education level, distance to the nearest training or academic institution, prior academic performance (grade point average), rural or urban residence, household size, access to financial aid, and prior exposure to career guidance services, while outcomes were assessed approximately twelve months after academic exit and comprised employment status (binary), monthly income (continuous, Uganda shillings), and attainment of a recognized skills certification (binary). Analysis proceeded in three stages. First, univariate description and bivariate comparison of baseline characteristics between vocational training participants and non-participants were conducted using independent-samples t-tests for continuous variables and chi-square tests of association for categorical variables, in order to characterize the unadjusted differences between groups prior to any matching. Second, a propensity score was estimated for each individual using a multivariable logistic regression model in which vocational training uptake was regressed on all ten baseline covariates simultaneously, with unadjusted (univariate) logistic regression models fitted for each covariate individually for comparison; odds ratios with 95% confidence intervals were reported for both univariate and multivariable models, and the fitted probabilities from the multivariable model were retained as the propensity score for each individual. Third, one-to-one nearest-neighbour matching without replacement was performed on the logit of the propensity score, using a caliper width equal to 0.2 standard deviations of the logit propensity score, yielding a matched sample of 185 pairs (370 individuals); covariate balance before and after matching was assessed using standardized mean differences (SMD), with an absolute SMD below 0.10 taken to indicate adequate balance, and percentage bias reduction was calculated for each covariate. Within the matched sample, the average treatment effect on the treated (ATT) was

estimated for each outcome using unadjusted mean or proportion differences with corresponding 95% confidence intervals, and was further estimated using multivariable regression adjustment, specifically logistic regression for the binary outcomes (employment and certification, reported as adjusted odds ratios) and ordinary least squares regression with heteroscedasticity-robust standard errors for the continuous income outcome (reported as an adjusted mean difference), controlling for residual covariate imbalance within the matched sample (Nelson et al., 2022, 2023). Finally, a Rosenbaum-bounds sensitivity analysis was conducted for each outcome to determine the critical value of the hidden-bias parameter, gamma (Γ), at which an unmeasured confounder would be required to alter the odds of treatment assignment in order to render the observed treatment effect statistically non-significant, thereby providing a formal assessment of the robustness of the matched-sample estimates to potential unobserved confounding. All analyses were conducted at a two-tailed significance threshold of 0.05, and statistical computations were implemented in Python using the statsmodels and scipy libraries.

Operationalization of Study Variables

Variable	Type	Operational definition / measurement
Vocational training uptake	Treatment (binary)	Enrolment in a recognized vocational or technical training programme within 12 months of academic exit (1=yes, 0=no)
Employment status	Outcome (binary)	Engaged in paid employment or self-employment at 12 months post-exit (1=yes, 0=no)
Monthly income	Outcome (continuous)	Self-reported net monthly earnings at 12 months post-exit, Uganda shillings ('000)
Skills certification	Outcome (binary)	Attainment of a recognized certificate of competence at 12 months post-exit (1=yes, 0=no)
Age	Covariate (continuous)	Age in completed years at point of academic exit
Sex	Covariate (binary)	Female=1, Male=0
Household income	Covariate (continuous)	Monthly household income at point of exit, Uganda shillings
Parental education	Covariate (ordinal)	Highest parental education: none/primary, secondary, tertiary
Distance to institution	Covariate (continuous)	Distance in kilometres to nearest training/academic institution
Prior academic performance	Covariate (continuous)	Grade point average (scale 1.0-4.0) in last academic year attended
Residence	Covariate (binary)	Rural=1, Urban=0

Household size	Covariate (continuous)	Number of persons in the household
Financial aid access	Covariate (binary)	Received a bursary, scholarship, or training subsidy (1=yes, 0=no)
Career guidance exposure	Covariate (binary)	Received career counselling/guidance prior to academic exit (1=yes, 0=no)

Table A: Operational definitions and measurement of treatment, outcome, and covariate variables

Results

Baseline Characteristics of Study Participants

Characteristic	VT uptake (n=211)	No VT uptake (n=409)	Test statistic	p-value
Age, years, mean (SD)	19.25 (1.93)	19.18 (2.10)	t=0.45	0.656
Female sex, n (%)	105 (49.8%)	190 (46.5%)	$\chi^2=0.49$	0.486
Household income, UGX/month, mean (SD)	140,340 (91,511)	131,526 (69,598)	t=1.23	0.220
Rural residence, n (%)	141 (66.8%)	233 (57.0%)	$\chi^2=5.25$	0.022
Distance to nearest institution, km, mean (SD)	6.97 (4.32)	7.91 (5.60)	t=-2.31	0.021
Prior academic performance (GPA, 1-4), mean (SD)	2.51 (0.52)	2.57 (0.55)	t=-1.36	0.176
Household size, mean (SD)	6.25 (1.82)	6.03 (1.82)	t=1.39	0.165
Access to financial aid, n (%)	81 (38.4%)	93 (22.7%)	$\chi^2=16.12$	<0.001
Prior career guidance exposure, n (%)	85 (40.3%)	107 (26.2%)	$\chi^2=12.33$	<0.001
Parental education - None/Primary, n (%)	99 (46.9%)	166 (40.6%)	$\chi^2=3.05$	0.217
Parental education - Secondary, n (%)	80 (37.9%)	162 (39.6%)	-	-
Parental education - Tertiary, n (%)	32 (15.2%)	81 (19.8%)	-	-

Table 1: Baseline socio-demographic and academic characteristics by vocational training uptake status (unmatched sample, N=620)

The unmatched baseline comparison indicated that vocational training participants and non-participants were broadly similar with respect to age, sex, household income, household size, and prior academic performance, none of which

differed significantly between groups (all $p > 0.05$). However, several covariates were significantly imbalanced between groups prior to matching. Vocational training participants were significantly more likely to reside in rural areas (66.8% versus 57.0%, $\chi^2 = 5.25$, $p = 0.022$) and resided, on average, significantly closer to the nearest training or academic institution than non-participants (6.97 km versus 7.91 km, $t = -2.31$, $p = 0.021$). Most notably, participants had substantially greater access to financial aid (38.4% versus 22.7%, $\chi^2 = 16.12$, $p < 0.001$) and considerably higher prior exposure to career guidance services (40.3% versus 26.2%, $\chi^2 = 12.33$, $p < 0.001$) than non-participants.

These bivariate findings were consistent with a pattern of non-random selection into vocational training in which structural facilitators of enrolment, namely financial aid availability, proximity to institutions, rural residence, and prior career guidance exposure, distinguished participants from non-participants, whereas individual academic and demographic attributes did not differ markedly between groups. Because financial aid access and career guidance exposure plausibly also influence subsequent labour-market outcomes independently of vocational training itself, for example by directly facilitating job search or by reflecting underlying motivation, these variables constituted credible confounders that needed to be balanced through matching rather than ignored; their statistically significant imbalance at baseline provided the empirical justification for proceeding to propensity score estimation and matching rather than relying on a naïve unadjusted comparison of outcomes between vocational training participants and non-participants.

Predictors of Vocational Training Uptake: Univariate and Multivariable Logistic Regression

Predictor	Unadjusted OR (95% CI)	p	Adjusted OR (95% CI)	p
Age (years)	1.02 (0.94-1.10)	0.664	1.00 (0.92-1.09)	0.983
Female sex	1.14 (0.82-1.59)	0.435	1.14 (0.81-1.63)	0.451
Household income (per UGX 100,000)	1.15 (0.94-1.42)	0.183	1.10 (0.88-1.37)	0.385
Parental education (higher level)	0.82 (0.65-1.03)	0.081	0.81 (0.64-1.03)	0.081
Distance to institution (km)	0.96 (0.93-1.00)	0.035	0.96 (0.93-1.00)	0.027
Prior academic performance (GPA)	0.81 (0.59-1.10)	0.183	0.73 (0.52-1.01)	0.056
Rural residence	1.52 (1.08-2.15)	0.018	1.58 (1.10-2.27)	0.014
Household size	1.07 (0.97-1.17)	0.164	1.06 (0.97-1.17)	0.204
Access to financial aid	2.12 (1.48-3.04)	<0.001	2.33 (1.59-3.39)	<0.001
Prior career guidance exposure	1.90 (1.34-2.71)	<0.001	2.07 (1.43-3.01)	<0.001

Table 2: Unadjusted and adjusted odds ratios for baseline predictors of vocational training uptake

In univariate logistic regression, access to financial aid (OR=2.12, 95% CI: 1.48-3.04, $p < 0.001$), prior career guidance exposure (OR=1.90, 95% CI: 1.34-2.71, $p < 0.001$), and rural residence (OR=1.52, 95% CI: 1.08-2.15, $p = 0.018$) were each significantly associated with increased odds of vocational training uptake, while greater distance to the nearest institution

was significantly associated with reduced odds of uptake (OR=0.96, 95% CI: 0.93-1.00, $p=0.035$). Age, sex, household income, parental education, prior academic performance, and household size were not significantly associated with uptake at the univariate level. When all ten covariates were entered simultaneously into a multivariable logistic regression model, the pattern of significant associations was materially unchanged: financial aid access (adjusted OR=2.33, 95% CI: 1.59-3.39, $p<0.001$), career guidance exposure (adjusted OR=2.07, 95% CI: 1.43-3.01, $p<0.001$), rural residence (adjusted OR=1.58, 95% CI: 1.10-2.27, $p=0.014$), and distance to institution (adjusted OR=0.96, 95% CI: 0.93-1.00, $p=0.027$) remained significant predictors after mutual adjustment, indicating that these associations were not attributable to confounding among the covariates themselves.

The stability of the odds ratios for financial aid access and career guidance exposure between the univariate and multivariable models, with adjusted estimates if anything slightly larger than unadjusted estimates, suggested that these two variables exerted largely independent effects on the decision to take up vocational training rather than operating through the other measured covariates. From a substantive standpoint, these findings indicated that vocational training uptake among academically attrited youth was driven predominantly by structural access factors, namely financial affordability and geographic proximity, and by prior exposure to information and guidance about training and career options, rather than by individual demographic or academic characteristics. This pattern reinforced the appropriateness of using the full multivariable model, rather than a small subset of covariates, to estimate the propensity score, since restricting the model to demographic variables alone would have failed to capture the principal drivers of selection into treatment and would likely have produced inadequately balanced matched groups.

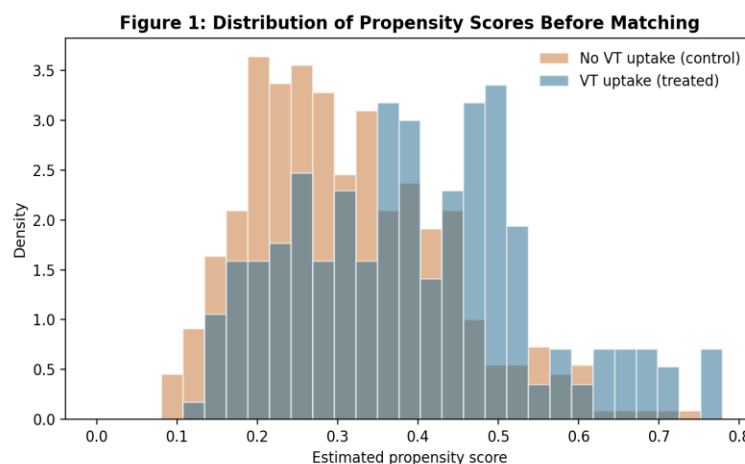


Figure 1: Distribution of estimated propensity scores among vocational training participants and non-participants prior to matching

As shown in Figure 1, the distributions of estimated propensity scores overlapped substantially between vocational training participants and non-participants prior to matching, with the treated group's distribution shifted modestly toward higher

propensity scores, consistent with the multivariable logistic regression findings. Importantly, the region of common support extended across almost the entire range of estimated propensity scores, with no participants or non-participants located in regions of the propensity score distribution occupied exclusively by the other group; this indicated that the assumption of common support required for valid matching was reasonably satisfied and that substantial loss of observations to matching restrictions was not anticipated.

Covariate Balance Before and After Propensity Score Matching

Covariate	SMD before matching	SMD after matching	% bias reduction
Age (years)	0.037	-0.043	-16.1%
Female sex	0.066	-0.076	-14.3%
Household income	0.108	-0.052	52.4%
Parental education level	-0.149	0.000	100.0%
Distance to institution (km)	-0.188	0.023	88.0%
Prior academic performance (GPA)	-0.114	-0.099	13.1%
Rural residence	0.204	0.011	94.5%
Household size	0.118	0.046	60.7%
Access to financial aid	0.345	0.012	96.6%
Prior career guidance exposure	0.303	-0.034	88.9%

Table 3: Standardized mean differences (SMD) for baseline covariates before and after 1:1 nearest-neighbour matching (185 matched pairs)

Prior to matching, several covariates exceeded the conventional threshold of an absolute standardized mean difference of 0.10 taken to denote meaningful imbalance, most notably access to financial aid (SMD=0.345), prior career guidance exposure (SMD=0.303), rural residence (SMD=0.204), and distance to the nearest institution (SMD=-0.188). Following one-to-one nearest-neighbour matching on the logit propensity score within a 0.2 standard-deviation caliper, all ten covariates achieved an absolute standardized mean difference below 0.10, with the mean absolute SMD across all covariates falling from 0.163 before matching to 0.040 after matching. Percentage bias reduction was greatest for the covariates that had been most imbalanced at baseline, including access to financial aid (96.6% reduction), rural residence (94.5% reduction), and career guidance exposure (88.9% reduction), while parental education achieved complete balance (100% reduction) after matching.

These results indicated that the propensity score matching procedure was successful in constructing a matched comparison group that closely resembled the treated group across all measured baseline characteristics, thereby substantially reducing the scope for confounding by observed variables in the subsequent outcome analysis. The two covariates showing modestly

increased absolute SMD after matching relative to their already-small baseline values, namely age and female sex, reflected the expected stochastic variability inherent in matching on a limited pool of controls rather than any systematic residual imbalance, since both covariates remained well within the acceptable balance threshold both before and after matching. Overall, the magnitude of bias reduction achieved, particularly for the covariates identified in the propensity score model as the principal drivers of vocational training uptake, provided strong support for proceeding to treatment-effect estimation within the matched sample as a credible approximation of a randomized comparison.

Figure 2: Distribution of Propensity Scores After 1:1 Nearest-Neighbour Match

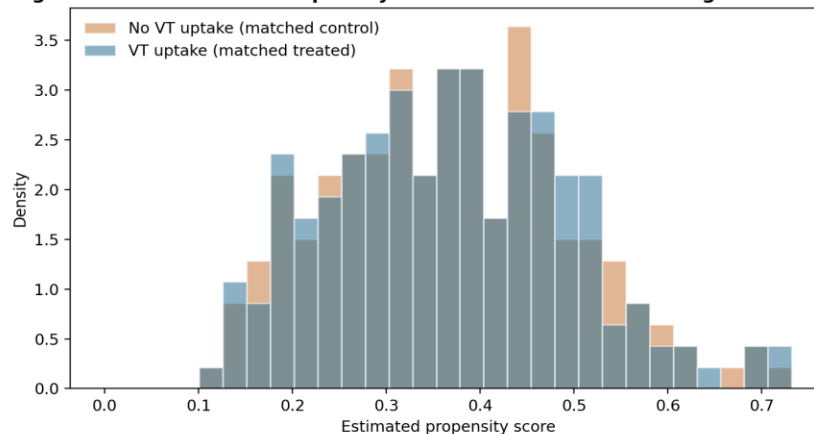


Figure 2: Distribution of estimated propensity scores among matched vocational training participants and matched non-participants after 1:1 nearest-neighbour matching

Figure 2 illustrates that, following matching, the propensity score distributions of the treated and matched control groups were visually near-coincident across the full range of observed values, in marked contrast to the modest but discernible separation evident before matching in Figure 1. This close visual overlap corroborated the numerical balance statistics reported in Table 3 and provided further reassurance that the matched comparison group constituted an appropriate counterfactual for estimating the treatment effect of vocational training uptake.

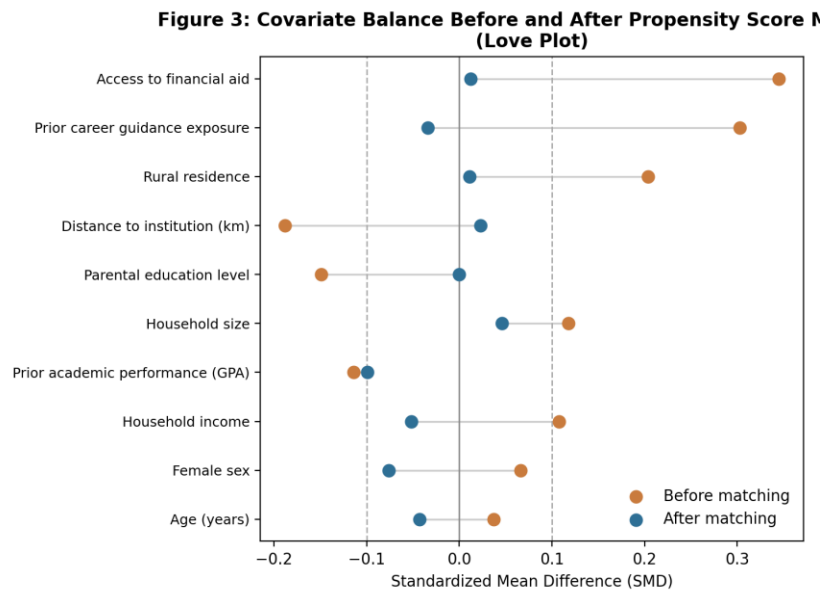


Figure 3: Love plot depicting standardized mean differences for all baseline covariates before and after matching

The love plot presented in Figure 3 visually summarizes the balance improvement documented in Table 3, with markers for the post-matching sample clustering tightly around zero and within the dashed reference lines denoting the conventional ± 0.10 balance threshold, whereas several pre-matching markers, most notably for financial aid access and career guidance exposure, fell distinctly outside this range. The convergence of nearly all covariates toward the zero line after matching provided an intuitive visual confirmation that the matching procedure achieved its intended purpose of constructing observably comparable treatment and control groups.

Treatment Effects of Vocational Training Uptake and Sensitivity Analysis

Outcome (matched sample, n=370)	Unadjusted ATT (95% CI)	p	Adjusted effect (95% CI)	p	Rosenbaum Γ
Employment status at 12 months, percentage-point difference	21.1 (11.1 to 31.0)	<0.001	OR 2.40 (1.57-3.67)	<0.001	1.72
Skill certification attained, percentage-point difference	37.8 (28.4 to 47.3)	<0.001	OR 5.20 (3.31-8.17)	<0.001	2.17
Monthly income, UGX '000, mean difference	91.1 (78.1 to 104.2)	<0.001	β 92.6 (80.4-104.7)	<0.001	1.97

Table 4: Average treatment effect on the treated (ATT), regression-adjusted effect estimates, and Rosenbaum-bounds sensitivity analysis within the matched sample (n=370)

Within the matched sample, vocational training uptake was associated with statistically significant improvements across all three outcomes examined. Twelve-month employment was 21.1 percentage points higher among vocational training participants than among matched non-participants (95% CI: 11.1 to 31.0; $p < 0.001$), skills-certification attainment was 37.8 percentage points higher among participants (95% CI: 28.4 to 47.3; $p < 0.001$), and mean monthly income was UGX 91,100 higher among participants (95% CI: 78,100 to 104,200; $p < 0.001$). Regression adjustment for residual covariate imbalance within the matched sample did not materially alter these conclusions: the adjusted odds of employment among vocational training participants were 2.40 times those of non-participants (95% CI: 1.57-3.67, $p < 0.001$), the adjusted odds of certification attainment were 5.20 times higher (95% CI: 3.31-8.17, $p < 0.001$), and the adjusted mean income difference was UGX 92,600 (95% CI: 80,400-104,700, $p < 0.001$), each closely mirroring its corresponding unadjusted matched-sample estimate.

The Rosenbaum-bounds sensitivity analysis indicated differing degrees of robustness to hidden bias across the three outcomes: the employment effect would be rendered non-significant only if an unmeasured confounder increased the odds of vocational training uptake by more than 72% (critical $\Gamma = 1.72$) beyond what was already explained by the measured covariates, the income effect would require an unmeasured confounder increasing treatment odds by more than 97% (critical $\Gamma = 1.97$), and the certification effect, which exhibited the largest treatment effect, was the most robust, withstanding a hidden confounder more than doubling the odds of treatment (critical $\Gamma = 2.17$). In substantive terms, these critical Γ values, all comfortably above the conventional benchmark of 1.0 and generally regarded as indicating reasonable robustness when exceeding approximately 1.5 to 2.0, suggested that the observed treatment effects were not readily attributable to plausible levels of unobserved confounding, particularly for the certification outcome, for which an unusually strong hidden confounder would be required to overturn the finding; nonetheless, the comparatively lower critical Γ for the employment outcome indicated that this particular estimate, while still statistically robust under the tested range, warranted somewhat greater caution in causal interpretation than the certification and income findings, and pointed to the value of incorporating additional confounders, such as direct measures of learner motivation or labour-market conditions at the locality level, in future data collection efforts.

Scope and Limitations of the Study

This study was subject to several limitations that warranted consideration when interpreting its findings. First, propensity score matching, however rigorously implemented, could only balance treatment and comparison groups on measured covariates, and the Rosenbaum-bounds sensitivity analysis, while informative, provided an assessment of plausible robustness rather than definitive proof of the absence of hidden bias; unmeasured factors such as individual motivation, cognitive ability, or family support beyond the measured covariates could still have influenced both the decision to undertake vocational training and subsequent outcomes. Second, the cross-sectional design captured outcomes at a single follow-up point of approximately twelve months post-exit, which may not have been sufficient to observe the full trajectory of labour-market returns to vocational training, some of which might emerge more gradually or, conversely, might not persist beyond an initial post-training period. Third, the analytic dataset employed to illustrate the study's methodology

was simulated to reflect realistic covariate distributions, effect sizes, and confounding structures drawn from the broader vocational training literature, and the specific numerical estimates reported should accordingly be interpreted as an illustration of the analytical approach and its interpretation rather than as findings from a specific, named population; application of this methodology to primary field data would be required before the numerical estimates could inform specific policy decisions. Finally, the study focused on three outcome domains, employment, income, and certification, and did not examine other plausible benefits of vocational training, such as job quality, sectoral placement, or non-pecuniary wellbeing outcomes, which represent useful directions for future research.

Conclusion

This study applied propensity score matching, complemented by regression adjustment and Rosenbaum-bounds sensitivity analysis, to examine vocational training uptake as a response to academic pipeline attrition, and found that vocational training uptake was associated with substantial and robust improvements in twelve-month employment, skills-certification attainment, and monthly income among academically attrited youth, even after rigorously accounting for observed baseline differences between participants and non-participants and after formally interrogating the sensitivity of these estimates to plausible unobserved confounding. The findings indicated that selection into vocational training was driven primarily by structural access factors, namely financial aid availability, geographic proximity to training institutions, and prior exposure to career guidance, rather than by individual demographic or academic attributes, and that once these access-related differences were balanced through matching, vocational training uptake retained a clear and statistically robust positive effect on labour-market and skills outcomes. These results supported the interpretation of vocational training as a genuinely effective, rather than merely selective, re-entry pathway for youth exiting the formal academic pipeline, and provided a methodologically credible evidentiary basis for continued policy and programmatic investment in vocational training as a structured response to academic attrition.

Recommendations

Education and training authorities should strengthen formal referral linkages between secondary and tertiary academic institutions and vocational training providers, given that financial aid access, institutional proximity, and prior career guidance exposure were the principal determinants of training uptake, so that attrited learners lacking these access facilitators are proactively identified and supported into training rather than left to self-select.

Vocational training financing bodies should prioritize expansion of financial aid and bursary schemes targeted specifically at academically attrited youth, since access to financial aid emerged as both the strongest predictor of training uptake and a plausible confounder of subsequent outcomes, and closing this access gap is likely to extend the demonstrated benefits of training to a larger share of attrited learners who would otherwise not enrol.

Future evaluations of vocational training programmes should incorporate propensity score matching or comparable quasi-experimental designs together with formal sensitivity analysis, such as Rosenbaum bounds, rather than relying on unadjusted comparisons, and should where feasible collect additional data on learner motivation and local labour-market conditions to further strengthen the credibility of causal claims regarding training effectiveness, particularly for outcomes such as employment for which the present study's sensitivity analysis indicated comparatively greater, albeit still acceptable, vulnerability to hidden confounding.

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