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Employment and Income Outcomes of Technology Skills Training Among Girls and Women in Africa: A case of Tech4Dev Women Techsters Fellowship Program

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Abstract

Background
Youth unemployment has become a prominent feature of African economies. This phenomenon runs in the background of a growing demand for digital/technology skills on the continent; there is an inadequate pool of tech talent to match the new jobs created in which women are increasingly been underrepresented. This study assesses the impact of recent efforts by an emerging organization, Tech4Dev, who seek to bridge the digital skills divide, particularly among underserved groups in Africa.

Methods
Data was collected from the graduating set of the Tech4Dev Women Techsters Fellowship Program 2021. A test of proportions was used to assess the impact of the training on income, while adjusted and unadjusted logistic regression models were used to examine the technology and sociodemographic factors associated with the rise in technology-related employment and income.

Results
Of the girls and women who undertook the technology skill-up training, 50.4% witnessed increments in their incomes, and 52.8% gained a technology-related job, business, or advanced educational opportunity. There was a significant increase in the proportion of girls and women who had incomes after the training than those who had incomes before the training. Efforts by Tech4Dev to place the fellows were distinctly among other factors in making a significant contribution to employment and income outcomes.

Conclusion
Our findings reveal that although a digital skills gap exists between gender in Africa, a veritable means of increasing economic opportunities for girls and women lies within the technology ecosystem. Realizing better livelihoods on the continent through technology upskilling would require large-scale interventions through public-private-non-profit partnerships beyond the significant efforts Tech4Dev is making.

Background

The rapidly growing ICT sector and its demand for new skills is an opportunity to improve the lives of millions of people. The economy has rapidly become ICT-driven. Not only has the way of working changed, but so has the set of skills required for numerous jobs. These skills concern practical knowledge of how to use digital tools like email and the Internet and how to structure a problem and evaluate large amounts of digital information (Levy, 2010).

In the current digital age, technology is widespread, and the digital transformation adaptation is described as the fourth digital revolution, where change occurs at a fast pace (World Economic Forum 2020). Digitalization is expected to boost the demand for digital skills and the importance of digital technology in all economic sectors. Technologies such as robots, artificial intelligence, and automation are already making major impacts on our economy. However, certain groups in society are lagging when it comes to such skills, affecting their opportunities in their job market and society in general.

Women, in particular, are severely underrepresented in ICT jobs; many lack access to technology. This gap is even more prominent in developing countries. It has been argued that women are at greater risk than men of being economically and socially excluded by the digital disruption currently taking place. This is partly because, typically, they spend more time on unpaid care work and have less access to formal education than men; also, it is because they tend to be discriminated against in terms of access to information, new technologies, and technology adoption/usage (Cheryl *et al.,* 2017). For context, the Female Labor Force Participation (FLFP) rate for women between 15 and 64 years old in Africa is one of the lowest globally, estimated at 21% in 2019, less than half of the FLFP rate globally (Klasen et al., 2019).

According to a study by Luxton, 2016 Women make up a majority of the four billion people excluded from the digital economy. A report by the European Commission on the 2020 Digital Economy and Society Index (DESI) concludes that more progress in digital skills is needed because 42% of the EU population still lacks at least basic digital skills. According to the e-economy Africa 2020 report, in Nigeria, about 23% of developers in Nigeria acquired technological skills through University Education, while the larger 77% did so through Informal Education such as Technology boot camps, online tech schools, and self-taught practices. This thereby encourages the need for more inclusion and training to skill up the women gender in technology adoption. Skill development is essential to remain at the forefront of innovation, efficiency, and competitiveness in an increasingly knowledge-driven global economy. Programs that build skills and prepare women for high-demand occupations can help foster job growth and employment.

Technology skills training among women in Africa has become critical to ensuring economic growth. While most countries are making great strides in ensuring equality and justice, more needs to be done about assisting people with low digital skills to adapt to the changing labor market. This will ensure that no one is left behind. The Netherlands has been one of the most digitalized countries in Europe for years. Yet, a substantial part of this country's population lacks basic digital skills (European Commission, 2019). Several studies have shown that ICT adoption has a positive effect on economic growth in a cross-country setting, but there is no

convincing empirical evidence on the labor-market effects of ICT skills at the individual level (most notably, Czernich et al., 2011).

A study carried out using unique data on ICT skills tested in 19 countries revealed a statistically and economically significant return to ICT skills: a one SD increase in ICT skills leads to an almost 24% increase in wages in the international sample and to an increase of 31% in the German sample (Falck et al., 2021). A policy review of the Digital Skills and labor market outcomes in the Netherlands using a unique dataset combining the 2012 OECD Survey of Adult Skills with registered data on labor market outcomes from 2012-2019 revealed that People with higher digital skills have four to six percent higher hourly wages and are ten percent more likely to be employed. The associations between digital skills and both wage and employment are stable over time, suggesting a long-lasting relationship with labor market outcomes (Non et al., 2021)

Despite the importance of digital skills in labor markets, there is very limited empirical evidence on the role of digital skills in Africa's labor markets. This study used data from a case study on the Tec4Dev Women Techstars Fellowship to study the impact of technology training on employment and wages among working women in Africa. The results suggest that technology skills training can improve employment outcomes. Our estimates suggest that earnings are slightly higher for participants with advanced technology skills than for participants with lower technology proficiency levels. If applied properly and appropriately, the rapid growth of ICTs across Africa may help women develop the skills they need to participate in the digital economy. One way to achieve this is by providing highly-tailored technology skills training.

Technology for Social Change and Development Initiative (Tech4Dev) Women Techsters Fellowship

Technology for Social Change and Development Initiative (Tech4Dev) is a non-profit social enterprise that seeks to create access to decent work and entrepreneurship opportunities and platforms for Africa through digital skills empowerment and advocacy. Women Techsters Fellowship, a flagship program of Tech4Dev, is a one-year hybrid learning program delivered through six months of intensive training, a six-month paid internship, and enrolment into a mentorship program to equip women with skills to build tech careers and tech-enabled businesses. Multiple cohorts will be executed over a 12-month timeline using standardized learning curriculums across the selected learning tracks for the next 10 years.

As part of the fellowship requirements, the fellows are assigned community tasks that could be executed physically or virtually. Fellows are assessed and graded at the end of the technical training classes. Fellows with the required pass grade are paired up for an internship.

Objectives:

- To support interested women with digital skills set relevant to the 21st century future of work
- To increase the number of women within the tech ecosystem
- To provide an avenue for women to learn deep tech skills for free

- To provide access to internship opportunities for graduated Fellows
- To increase the number of women with access to decent jobs and digital skills

The Next Five Years (2022 – 2027)

The Women Techsters Fellowship is part of a larger program called the Women Techsters (WT) Initiative which includes advocacy programs, open days, bootcamps and the fellowship. Over the next five years, the Women Techsters (WT) initiative will scale its impact to 810,000 girls and women across 24+ African countries. Of all the sub-programs of the Women Techsters program, 3% are typically accepted into the fellowship. Through scaled partnership efforts, the initiative projects to place at least 23,100 beneficiaries of its fellowship program in a paid internship or full-time technology roles. The table below shows the distribution of the projected impact.

Table 1: Projected Impact of Women Techsters Initiative in Nigeria (2022-2027)

Year	Total Target	Distribution for WT Fellowship
2021/2022	10,000	300
2022/2023	50,000	1,500
2023/2024	100,000	3,000
2024/2025	250,000	7,500
2026/2027	400,000	12,000
Total	**850,000**	**24,300**

Methods

Data and Sample

The data for this study was collected from the graduating set of the Tech4Dev women techsters fellowship program 2021. A total of 4,908 girls and Women from Africa initially applied for the program. The applicants for the program were screened based on whether they:
(1) had access to a well-functioning computer with internet connectivity;
(2) were willing to be available for the duration of the program calendar;
(3) had basic digital literacy skills;
(4) had a specific interest to develop a career in technology;
(5) were between ages 16-40;
(6) and were located in Nigeria, Ghana, Egypt, Kenya, and South Africa.

The countries were selected purposively due to their relative population and technology dominance in Africa (see Table 2).

Table 2: Country sample for study

Country	Expected Participants	Actual Participants	Graduated
	N (%)	N (%)	N (%)
Nigeria	158 (52.6)	190 (63.3)	75 (59.1)
Kenya	37 (12.3)	43 (14.3)	24 (18.9)
Egypt	42 (14)	50 (16.7)	11 (8.7)
South Africa	47 (15.8)	35 (11.7)	13 (10.2)
Ghana	16 (5.3)	20 (6.7)	4 (3.2)
Total	**300 (100)**	**338 (100)**	**127 (100)**

After the screening process, 338 girls and women emerged as participants in the intermediate skills training. Of those who participated in the training, 127 girls and women successfully graduated, representing the study sample. All the 127 girls and women in the graduating WT fellowship 2021/2022 graduating set willingly participated in the survey. Responses were collected from the 15th of March 2021 to the 3rd of April 2021 using Microsoft Forms.

Variables and Measurement

The outcomes variables of interest were a two-category nominal measure of income outcome and employment status. The income change measure focused on whether the incomes of the graduating set increased or not after the training. Respondents were asked to state their current monthly income, which was subtracted from their initial income before the training. An increment in income was categorized as "positive" and "not-positive" if otherwise. Employment status was categorized as "tech-engaged" if the respondent stated that she was currently engaged in a technology-enabled activity (i.e., business, education, or job). Respondents' employment status was categorized as "non-tech-engaged" if they were engaged in a non-technology-enabled activity or unemployed.

To explore technology and socio-demographic differences, we disaggregated the girls and women by age group, education level, marital status, number of dependents, information and communication technology (ICT) background, learning track, and placement. The age group was categorized into 15-19, 20-24, 25-29, and 30-40. Education level was categorized as secondary school, diploma, and university. Marital status was classed into never, currently, and previously married. The number of dependants was an ordinal variable comprising zero, one, two, three, four, and above four.

Respondents were asked about their course of study, and responses that were related to ICT-related courses were coded as "1" and assigned "yes," otherwise were coded as "0" and assigned "no." The learning track denotes the technology skills (cyber security, data science and artificial intelligence, product design, product management, and software development) the participants were initially placed into at the start of the training. Moreover, as part of the objectives of Tech4Dev, the organization undertakes an intervention program called placement, which seeks to place beneficiaries in technology-related work. Thus, the placement measure is a nominal variable categorized as "Tech4Dev placed", "non-Tech4Dev placed," and "not-placed." Participants were categorized as "Tech4Dev placed" if they were

placed in a job by Tech4Dev; "non-Tech4Dev placed" if they found a job without the help of Tech4Dev, and "not-placed" if they did not find a job at all.

Statistical Analysis

We used descriptive statistics, such as frequencies and percentages, to present the outcomes and explanatory variables of the study. Pearson's chi-square test and bivariable and multivariable logistic regression model were used to examine the technology, demographic and socioeconomic factors associated with tech-employment and income outcome of Tech4Dev's 2021/2022 Women Techsters' Fellows. We estimated the 95% confidence interval (CI) for the odds ratios (OR) and used the p-value significance threshold of < 0.05 for all tests. The analyses were carried out using STATA Version 16.0 and Microsoft Excel Version 2019.

Ethical Statement Responses

Ethical principles guiding the use of human participants in the research were adhered to. From the application to the graduation phase of the program, all participants were duly informed about the use of the data for monitoring, evaluation, research, and learning purposes. Participation in the impact study was completely voluntary, as the fellows could freely decide whether to participate in the survey.

Results

Descriptive and univariable findings

A total of 127 women of the Tech4Dev Women Techsters Fellowship 2021/2022 beneficiaries were included in the study. The sociodemographic and technology characteristics of the respondents are presented in Table 3. The majority of the study participants were Nigerians (59.1%), aged 20 – 29 (69.3%), never married (77.2%), had dependents (67.7%), possessed a university education (80.3%), without Information and Communication Technology (ICT) background (75.6%), **and placed in a technology-related business, education or job (59.8%).**

Table 3: Technology, Socio-demographic characteristics of the study participants

Variables	Frequency	%
Age Group		
15 – 19	6	4.7
20 – 24	34	26.8
25 – 29	54	42.5
30 – 40	33	26.0
Marital Status		
Currently Married	27	21.3
Never Married	98	77.2
Previously Married	2	1.6
Dependents		
Zero	41	32.3
One	23	18.1
Two	22	17.3
Three	17	13.4
Four	11	8.7
Above four	13	10.2
Above zero	86	67.7
Education Level		
Secondary school	14	11.0
Diploma	11	8.7
University	102	80.3
Non University	25	19.7
ICT Background		
No	96	75.6
Yes	31	24.4
Learning Track		
Cyber Security	17	13.4
Data Science and AI	47	37.0
Product Design	23	18.1
Product Management	9	7.1
Software Development	31	24.4
Placement		
Tech4Dev Placed	30	23.6
Non Tech4Dev Placed	46	36.2
Not Placed	51	40.2

What is more, the majority of the participants at the end of their training had an increment in their incomes, as shown in Figure 1. Likewise, as portrayed in Figure 2, most of the participants were engaged in a technology-related career (advanced education, business, or job) by the end of their training.

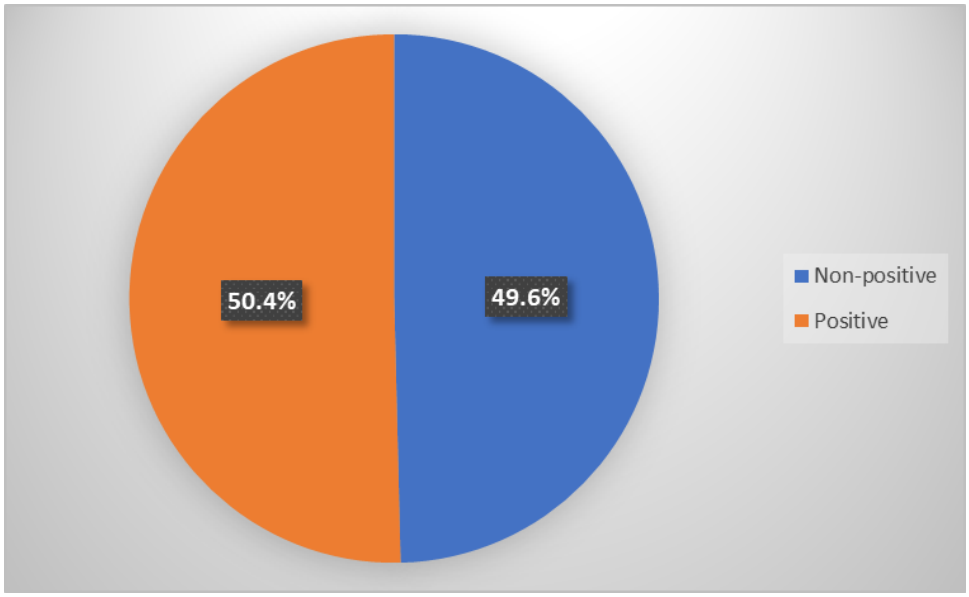

Fig. 1 Income

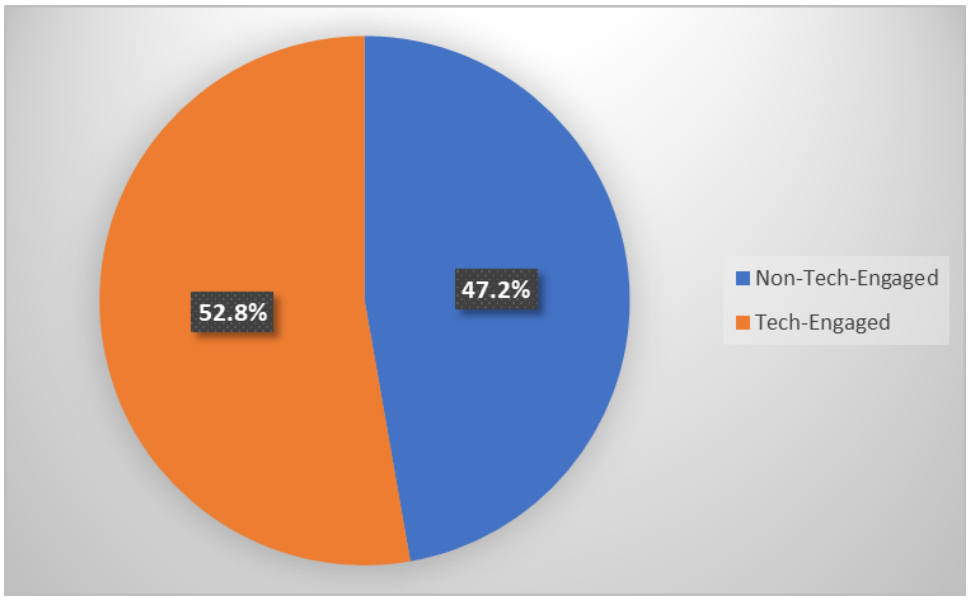

Fig. 2 Employment

We also checked to see if there is a statistically significant difference between the number of those who had incomes before the training and those who had incomes after the training using the test of proportions (Pr-test). To conduct the test, we recategorized the continuous income variable into a binary outcome variable, where respondents with no income were coded as "0" and those with some incomes were coded as "1". The result of the test for differences in proportions between participants who earned some income before and after is presented in Table 4. We find that the proportions are statistically different from each other at

any level greater than 4.9%. Therefore, significantly more beneficiaries had income after the training compared to those who had income before the training.

Table 4: Test of proportions for earnings before and after the training program

	Mean	Std. Err.	[95% Conf. Interval]		Z Score	P-value
Pr-test					-1.97	0.049
Income Before	0.669	0.042	0.587	0.751		
Income After	0.780	0.037	0.707	0.852		

Bivariable and Multivariable findings

Table 5 reports the proportion of respondents who had increments in their incomes after the training by their socio-demographic and technological characteristics. As Figure 1 shows, approximately half of the women witnessed positive changes in their incomes; however, the proportion varied across sociodemographic and technological characteristics. More married than non-married (51.9% vs. 50.0%), dependent carriers than non-dependent carriers (52.3% vs. 46.3%), university-educated than non-university educated (53.9% vs. 36.0%), Tech4Dev placed than non-Tech4Dev placed (71.7% vs. 56.9%) had positive changes in their incomes by the end of the training.

We fitted two models to examine possible characteristics associated with a positive change in income. The first model was an unadjusted model with no covariates, while the second was an adjusted one with covariates. In the unadjusted model in Table 5, women were significantly more likely to experience increments in their incomes only if they were Tech4Dev placed (UOR: 22.85; 95% CI: 5.90,88.52). In the adjusted model, women aged 25 to 29 (AOR: 20.12; 95% CI: 1.49,271.53) and Tech4Dev placed (AOR: 39.26; 95% CI: 8.17,188.66) were significantly more likely to witness positive changes in their incomes. On the contrary, women who took the data science and AI learning track were less likely to have positive changes in their incomes (AOR: 0.16; 95% CI: 0.03,0.84).

Table 5: Logistic regression analysis showing the association between sociodemographic and technology characteristics and income

Income	Increment N (%)	UOR [95% CI]	AOR [95% CI]
Age group			
15-19	1 (16.67)	Ref	Ref
20-24	16 (47.06)	4.44 [0.47,42.17]	12.95 [0.85,198.36]
25-29	32 (59.26)	7.27 [0.79,66.60]	20.12* [1.49,271.53]
30-40	15 (45.45)	4.17 [0.44,39.68]	14.2 [0.90,224.03]
Country			
Egypt	5 (45.45)	Ref	Ref
Ghana	3 (75)	3.6 [0.28,46.36]	1.93 [0.11,34.74]
Kenya	10 (41.67)	0.86 [0.20,3.61]	1.75 [0.28,10.96]
Nigeria	43 (57.33)	1.61 [0.45,5.75]	1.54 [0.32,7.51]
South Africa	3 (23.08)	0.36 [0.06,2.08]	0.26 [0.03,2.58]
Marital Status			
Not Married	50 (50)	Ref	Ref
Married	14 (51.85)	1.08 [0.46,2.52]	0.68 [0.19,2.52]
Dependents			
No	19 (46.34)	Ref	Ref
Yes	45 (52.33)	2.08 [0.84,5.14]	1.54 [0.40,5.93]
Education			
Non-University	9 (36)	Ref	Ref
University	55 (53.92)	1.27 [0.60,2.68]	1.36 [0.43,4.33]
ICT Background			
None	53 (55.21)	Ref	Ref
Yes	11 (35.48)	0.45 [0.19,1.03]	0.56 [0.17,1.82]
Learning Track			
Cyber Security	9 (52.94)	Ref	Ref
Data Science and AI	19 (40.43)	0.6 [0.20,1.84]	0.16* [0.03,0.84]
Product Design	12 (52.17)	0.97 [0.28,3.40]	0.26 [0.04,1.80]
Product Management	5 (55.56)	1.11 [0.22,5.63]	0.14 [0.02,1.23]
Software Development	19 (61.29)	1.41 [0.43,4.65]	0.37 [0.07,2.07]
Placement			
Not Placed	3 (10)	Ref	Ref
Tech4Dev Placed	33 (71.74)	22.85*** [5.90,88.52]	39.26*** [8.17,188.66]
Non Tech4Dev Placed	28 (54.9)	10.96*** [2.94,40.78]	23.85*** [5.02,113.30]

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, UOR: unadjusted odds ratio, AOR: adjusted odds ratio

Furthermore, the proportion of respondents who had technology-related employment or engagement after the training by their sociodemographic and technology characteristics was presented in Table 6. Of the 52.8% of women who had a tech-related engagement, more were married (56%) than non-married (40.74%), had a university education (52.94%) than without a university education (52%), had an ICT background (54.84%) than without ICT background (52.08%), had dependents (53.49%) than without dependents (51.22%), and were Tech4Dev placed (82.61%) than non-Tech4Dev placed (56.86%).

The summary of the results examining the possible association between technology-related employment or engagement and technology and sociodemographic characteristics was also presented in Table 6. The unadjusted model shows that participants who undertook the software development learning track and those placed by Tech4Dev were significantly related to having technology-related employment or engagement. In the adjusted model, participants placed by Tech4Dev were four times more likely to have technology-related employment than those not placed at all. However, respondents who were married were less likely to have a technology-related engagement than those who were not married.

Table 6: Logistic regression analysis showing association between socio-demographic and technology characteristics and technology-related employment/engagement

Employment	Tech-engaged N (%)	UOR [95% CI]	AOR [95% CI]
Age group			
15-19	5 (83.33)	Ref	Ref
20-24	19 (55.88)	0.25 [0.03,2.41]	0.51 [0.03,9.25]
25-29	25 (46.3)	0.17 [0.02,1.58]	0.16 [0.01,2.06]
30-40	18 (54.55)	0.24 [0.03,2.29]	0.27 [0.02,3.27]
Country			
Egypt	6 (54.55)	Ref	Ref
Ghana	1 (25)	0.28 [0.02,3.58]	0.32 [0.01,7.81]
Kenya	9 (37.5)	0.5 [0.12,2.12]	0.53 [0.06,4.36]
Nigeria	43 (57.33)	1.12 [0.31,4.00]	1.25 [0.19,8.35]
South Africa	8 (61.54)	1.33 [0.26,6.81]	1.04 [0.09,12.25]
Marital Status			
Not Married	56 (56)	Ref	Ref
Married	11 (40.74)	0.54 [0.23,1.28]	0.23* [0.05,0.96]
Dependents			
No	21 (51.22)	Ref	Ref
Yes	46 (53.49)	1.04 [0.43,2.49]	0.56 [0.10,3.03]
Education			
Non-University	13 (52)	Ref	Ref
University	54 (52.94)	1.1 [0.52,2.31]	1.45 [0.34,6.15]
ICT Background			
None	50 (52.08)	Ref	Ref
Yes	17 (54.84)	1.12 [0.50,2.52]	1.05 [0.25,4.38]
Learning Track			
Cyber Security	5 (29.41)	Ref	Ref
Data Science and AI	24 (51.06)	2.5 [0.76,8.23]	4.19 [0.68,25.60]
Product Design	12 (52.17)	2.62 [0.70,9.86]	3.16 [0.34,29.77]
Product Management	5 (55.56)	3 [0.56,16.07]	0.67 [0.07,6.63]
Software Development	21 (67.74)	5.04* [1.39,18.25]	4.51 [0.67,30.21]
Placement			
Not Placed	0 (0)		
Tech4Dev Placed	38 (82.61)	3.60** [1.40,9.25]	3.93* [1.22,12.67]
Non Tech4Dev Placed	29 (56.86)	1 [1.00,1.00]	1 [1.00,1.00]

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, UOR: unadjusted odds ratio, AOR: adjusted odds ratio

Discussion

This paper examines the employment and income outcomes of Technology skills training programs among women in Africa, using the example of the Tec4Dev Women Techstars fellowship. Technology skills training among women in Africa has become critical to ensuring economic growth. Despite the importance of digital skills in labor markets, there are very limited studies on the role of digital skills in Africa's labor markets. The rising digital skills gap between males and females is one of the main issues facing most of the African continent. The majority of our participants had a university education. However, about three-quarters had no ICT background. A few of the participants were below 20 years.
Findings in the literature indicate that low-skilled workers in the labor market face higher unemployment rates and lower levels of job security (Falck et al., 2021; Non et al., 2021). Our results suggest that new digital technologies can help to increase labor market participation and income-earning opportunities among women. The employment results indicate no significant difference in the employment outcomes between all the participants who took part in the technology skills training. The results are consistent with a finding from the Program for the International Assessment of Adults Competencies (PIAAC) survey, which used data from vocational skill training in Korea. The study showed a strong positive effect of vocational skill training programs on earnings as well as on the employment probability of individuals while controlling for sociodemographic factors (Lee et al., 2019). A recent policy paper by the National Skills Coalition finds that women who participated in digital skills training improved their employability and earning power and built skills to access future opportunities (Bergson-Shilcock, 2020).

What is more, all the women in technology skills training had a fair chance of improving their employment and income prospects, irrespective of sociodemographic characteristics. This finding reveals the strong impact of the Tech4Dev initiative. Critical to the initiative is the importance of the placement intervention Tec4Dev undertakes for its beneficiaries. The study reveals that women who were placed by the organization were far more likely to gain technology-related jobs, business, or advanced education and have increments in their incomes.

People without digital skills training participate less often in the labor force, making them dependent on either a working partner or other sources. There are concerns that this group is in an unstable job position and is more likely to be unemployed or in a temporary contract. The need to find solutions that can help women in Africa to get the employment they deserve and be a catalyst for their economic advancement has prompted many organizations and individuals to come up with ideas on how to do this. Tech4Dev is an organization that has come up with an action plan based on women empowerment through digital skill training. Learning from the Tech4Dev model in skilling women up in the use of high-earning technology tools. Results from this study suggest that acquiring digital skills helps create veritable access to today's labor market. In addition, increasing skills further from the basic level to the advance level might lead to better labor market outcomes.

By way of recommendation, educational institutions at all levels need to incorporate digital and technology skills training in their curriculum to ensure that graduates acquire employability and high-income skills required for future work. Policy interventions should be geared towards motivating women's participation in the digital economy. It has been

remarked that the government cannot do the work of fostering the digital economy. Therefore, Public-Private-Non-Profit partnerships can be established and strengthened to promote intervention programs around Africa, at the national and sub-national level, to take advantage of the opportunities presented by model programs such as the Tech4Dev women Techster fellowship technology skills training. At a larger scale, such initiatives can play an important role in helping millions of Africans out of poverty in a post-covid world.

Conclusion

Technology skills training among women in Africa is essential for countries to compete in increasing knowledge and technology-driven global economy. The key findings from this study show that technology skills training can positively impact employment and wage outcomes among females in five African countries. This is paramount in a continent with rising youth unemployment among graduates and an increasing gender gap in the digital ecosystem. One of the keys to the development and growth of nations in the modern world is digital education. Information and Communication Technologies (ICTs) have proved to be increasingly fundamental to the socio-economic development of any country. They are important tools that can provide women access to lifelong learning, education, and training. Neglecting to give women access to these tools not only deprives them and their families of income but also reduces the skill levels of the nation, limits productivity, and bars a country from being competitive in the global market. Advances in technology-based education and solutions can help in bridging the employment and income gap.

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