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Perceived Risk Factors in the Implementation of 5G Technology: A Quantitative Assessment

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Abstract

Introduction: The advent of 5G is expected to revolutionise how we interact with technology, offering enhanced performance for everything from smart devices and autonomous vehicles to advanced healthcare and industrial automation. 5G technology represents a significant leap forward in mobile communications, promising unprecedented data speeds, ultra-low latency, and massive connectivity that will enable new applications and services across various sectors.

Objective: This study evaluates perceived risks associated with 5G technology, focusing on health, environmental, and cybersecurity concerns.

Methods and Materials: This study adopted a quantitative descriptive research design to quantify Jamaicans' perceptions of 5G technology risk factors. Data were obtained through a standardised survey administered to participants from various backgrounds. The questionnaires included questions on health concerns, environmental impacts, and cybersecurity issues related to 5G technology, as well as demographic information to allow for analysis of correlations and trends.

Findings: Older participants are more concerned about health risks associated with the advent of 5G technology. There was no significant difference in environmental concern between genders. IT professionals are more concerned about cybersecurity risks than non-IT professionals. Urban participants are generally more concerned about all aspects of 5G technology than those from rural areas are, and higher education correlates with increased concern about cybersecurity risks.

Conclusion: The research highlights several critical areas of concern regarding 5G technology, including health risks, environmental impacts, and cybersecurity. The findings underscore the importance of targeted risk communication and the need for continued research and dialogue to address public concerns effectively.

Keywords: Cyberattacks, cyber security, 5G technology, environmental risks, health concerns, public perception

Introduction

The advent of 5G is expected to revolutionise how we interact with technology, offering enhanced performance for everything from smart devices and autonomous vehicles to advanced healthcare and industrial automation. 5G technology is a significant advancement in mobile communications, promising unprecedented data speeds and ultra-low latency. This advancement holds the potential to drive innovation and economic growth, transforming industries and improving quality of life. However, as with any major technological shift, the deployment of 5G brings a range of concerns that need to be addressed.

The benefits of 5G are accompanied by concerns about its potential impacts on health, the environment, and cybersecurity. As 5G networks are rolled out and integrated into existing infrastructure, stakeholders-from policymakers and industry leaders to the general public-have raised questions about the potential risks. Understanding these perceived risks is crucial for ensuring that 5G technology is deployed in a manner that addresses public concerns and fosters trust. This study aims to explore these concerns in depth, providing a comprehensive assessment of the risks associated with 5G technology.

Statement of the Problem

Despite its potential benefits, the rollout of 5G has triggered public concerns surrounding health risks, environmental impact, and cybersecurity vulnerabilities. These concerns include potential health risks associated with increased exposure to electromagnetic fields (EMFs), which some believe could adversely affect human health. Environmental impacts are also a significant concern, with questions about how the increased use of 5G infrastructure might affect wildlife and ecosystems. Additionally, the heightened connectivity provided by 5G raises cybersecurity concerns, as the expansion of the network could introduce new vulnerabilities to data breaches and cyberattacks. Addressing these concerns is essential to facilitate the broader adoption of 5G technology while ensuring public trust and safety.

The challenge lies in balancing the promising benefits of 5G with the need to mitigate any potential risks. As technology continues to evolve and become more integrated into everyday life, it is crucial to address these concerns proactively. This study aims to shed light on these issues, providing a clearer understanding of the perceived risks associated with 5G and offering insights that can guide policymakers, industry stakeholders, and the public in making informed decisions about its deployment.

Significance of the Study

The study is essential for many reasons.

For Policymakers

- Provides insights to guide regulations and standards, ensuring safe 5G deployment and addressing public concerns.

For Public Awareness

- Offers evidence-based information to counter misinformation, helping the public make informed decisions about 5G.

For Industry Practices

- It helps companies understand stakeholder concerns, leading to safer, more secure 5G infrastructure and improved service quality.

Purpose of the Study

This study aims to investigate the perceived risks associated with 5G technology, focusing on three main areas: health, environmental, and cybersecurity. By examining these areas, the study seeks to comprehensively assess the concerns raised by public opinions and other stakeholders. The study will determine public concerns regarding the health implications of prolonged exposure to 5G EMFs, exploring whether the evidence supports these concerns and how they impact public perception.

Additionally, the study will explore the potential ecological impacts of 5G infrastructure, particularly on wildlife and ecosystems. Understanding these environmental risks is crucial for developing strategies to minimise adverse effects and promote sustainable practices. Finally, the study will evaluate fears of cybersecurity risks associated with increased connectivity, such as data breaches and cyberattacks. By addressing these three areas, the study aims to provide valuable insights into the perceived risks of 5G technology and offer recommendations for mitigating these risks.

Rationale for the Study

As 5G technology advances, concerns about its health, cybersecurity, and environmental impacts are growing. However, limited research shows how these concerns differ by age, education, and technical knowledge. This study will fill this gap by examining how various groups perceive 5G risks, helping policymakers and industry leaders address public concerns and make informed decisions.

General Research Objective

This study evaluates selected perceived risks associated with 5G technology.

General Research Question

What are the perceived risks associated with 5G technology? This study provides additional information by examining related research questions.

Research Questions

The study seeks to answer the following research questions:

1. What are the primary health concerns related to 5G technology? This question aims to identify the health risks the public perceives and understand the basis of these concerns.
2. How does the public perceive the environmental impacts of 5G infrastructure? This question explores the perceived ecological risks associated with deploying 5G technology.
3. What are the predominant cybersecurity risks the public perceives when adopting 5G? This question evaluates the concerns related to data breaches and cyberattacks that may arise from increased connectivity.

By addressing these questions, the study aims to provide a detailed understanding of the perceived risks associated with 5G technology from public perception, offering insights that can inform future research and policy development.

Limitations of the Study

The following are the fundamental limitations of this study:

1. **Geographical and Demographic Specificity:** This study focuses on individuals' perceptions in a specific geographical region. While it provides valuable insights into their views on the risks associated with 5G technology, the findings may only be generalisable to similar demographics or regions. They may not extend to other populations or areas.
2. **Stakeholder Representation:** The study's concentration on individuals means that the perspectives of other important stakeholders, such as the general public or policymakers, still need to be fully captured. This limitation restricts the comprehensiveness of the study's conclusions.
3. **Reliance on Self-Reported Data:** The data collected is based on self-reported information, which may be subject to biases and inaccuracies. Various factors, such as personal experiences and exposure to information, could influence participants' perceptions and concerns, introducing potential limitations in the accuracy and reliability of the findings.

Delimitations of the Study

The following are the delimitations of this study:

1. **Survey Methodology:** The study employs a survey-based methodology to gather data. While this method is suitable for capturing perceptions and self-reported data, it excludes other possible methodologies, like qualitative interviews or experimental designs, which could offer different insights.
2. **Scope of Risk Factors:** The study examines perceived risks associated with 5G technology. To maintain a clear focus on perceived risks, this scope deliberately omits a broader examination of the potential benefits of 5G technology or a detailed analysis of technical aspects.

Literature Review

Introduction

The introduction of 5G technology marks a transformative leap in communication capabilities, promising unprecedented speeds, enhanced connectivity, and a wealth of opportunities for technological advancements. As Chiaraviglio et al. (2021) explain, 5G offers significantly faster data transfer rates, ultra-low latency, and the capacity to connect many devices simultaneously. This new generation of mobile technology is set to revolutionise various sectors, including the Internet of Things (IoT), autonomous vehicles, and smart cities, by providing more efficient and reliable connectivity (Yee, 2023). The enhanced performance of 5G is expected to drive innovation and improve efficiency across multiple domains, paving the way for previously unattainable advancements.

However, the rapid deployment and integration of 5G technology also bring a range of significant concerns that need to be addressed. These concerns encompass environmental impacts, such as the effects of increased electromagnetic field (EMF) exposure on wildlife and ecosystems (Fernández-Bellon & Kane, 2020), as well as heightened cybersecurity risks due to the expanded attack surface created by the proliferation of connected devices (Panwar et al., 2021). Public health concerns have also been raised regarding the potential long-term effects of radiofrequency (RF) exposure associated with 5G technology (Simkó & Mattsson, 2019). Addressing these issues is crucial to ensure the successful and responsible deployment of 5G technology, fostering public trust and safeguarding environmental and human health.

Technological Advancements of 5G

5G technology offers several advancements over previous generations, including faster data speeds, lower latency, and the capability to connect many devices simultaneously. These advancements are expected to revolutionise various sectors by enabling real-time data exchange and facilitating complex applications such as autonomous vehicles, smart grids, and advanced healthcare systems (Chiaraviglio et al., 2021). The technology's support for emerging fields like artificial intelligence (AI) and the Internet of Things (IoT) opens up immense opportunities for innovation and efficiency across multiple industries (Yee, 2023).

However, the deployment of 5G technology also presents challenges, particularly related to the infrastructure required to support its higher frequencies. The need for a denser network of base stations and antennas to ensure optimal performance and coverage can lead to various environmental and infrastructural concerns. These include the impact of increased electromagnetic field (EMF) exposure and the potential disruption to urban landscapes. Addressing these challenges is essential to maximise the benefits of 5G while mitigating any adverse effects associated with its implementation.

Environmental Risks of 5G

The deployment of 5G technology involves a significant increase in the density of base stations and antennas, particularly in urban areas. This densification can have several environmental

impacts, especially on wildlife sensitive to electromagnetic fields (EMFs), such as birds and insects. The increased presence of 5G infrastructure in natural and urban environments could disrupt habitats and alter animal behaviour, potentially leading to changes in population dynamics and ecological balance (Fernández-Bellon & Kane, 2020).

Moreover, recent studies have highlighted the potential adverse effects of EMFs on wildlife, including disruptions to navigation and reproductive cycles (Balmori, 2021). To address these concerns, more research is needed to understand the full extent of the environmental impact of increased EMF exposure. This research is crucial for developing strategies to mitigate potential ecological damage and ensure that the benefits of 5G technology do not come at the expense of environmental health (Thielens et al., 2020).

Cybersecurity Risks of 5G

Integrating 5G networks with critical infrastructure and the proliferation of connected devices significantly heightens cybersecurity risks. The expanded attack surface created by increased connectivity introduces potential vulnerabilities, including data breaches and cyberattacks (Panwar et al., 2021; Ericsson, 2020). The dual nature of 5G—enabling advancements while presenting new security challenges—underscores the need for robust security protocols and continuous monitoring to protect against emerging threats (U.S. Department of Homeland Security, 2020).

Understanding how perceived risks, such as privacy and security concerns, affect consumers' and businesses' willingness to adopt 5G technology is essential for developing effective security measures. Addressing these concerns through comprehensive security frameworks and transparent communication is vital for fostering confidence in 5G networks and ensuring their safe and secure operation (Alam & Anwar, 2021).

Health Risks of 5G

Health concerns related to 5G technology remain a primary public issue, with ongoing debates about the potential health effects of prolonged exposure to radiofrequency (RF) fields. Studies have explored links between RF exposure and health issues such as headaches, fatigue, and other symptoms (Simkó & Mattsson, 2019; Chiaraviglio et al., 2021). Despite these concerns, many reviews conclude that exposure levels from 5G are within international safety guidelines, although the long-term effects are still uncertain and require continuous monitoring (Foster & Moulder, 2020).

Addressing public health concerns involves ongoing research and transparent communication to mitigate fears and provide accurate information. Ensuring that public health assessments are based on comprehensive and current scientific evidence is crucial for maintaining public trust and supporting the responsible deployment of 5G technology (Allianz Commercial, 2023).

Public Perception and Risk Communication

Various factors, including media coverage, scientific evidence, and risk communication strategies, influence public perception of 5G technology. Effective risk communication is critical in shaping public perception and addressing concerns through transparent and evidence-based communication (Cabrera & Lee, 2020; Leszczynski, 2021). Addressing misconceptions and providing accurate information about the risks and benefits of 5G is essential for gaining public trust and acceptance.

Transparent communication helps to address perceived risks and fosters a better understanding of the technology's implications. By implementing effective communication strategies, stakeholders can enhance public confidence in 5G technology and support its successful integration into society (Alam & Anwar, 2021).

Regulatory and Policy Considerations

The deployment of 5G technology requires careful regulatory and policy frameworks to ensure safety and security. Countries have adopted various approaches to regulate 5G, focusing on spectrum allocation, cybersecurity standards, and health guidelines. Strategic initiatives and priorities aimed at protecting 5G infrastructure from cyber threats and ensuring its reliability have been outlined by governmental bodies (Cybersecurity and Infrastructure Security Agency, 2020).

Regulatory measures to limit RF exposure and safeguard public health are crucial for ensuring the safe deployment of 5G technology. Policymakers must balance the benefits of 5G with the need to protect public and environmental health, ensuring that regulations are based on the latest scientific evidence. Comprehensive security frameworks and strategic planning are essential for managing risks while leveraging the advantages of 5G (EY, n.d.; Protiviti, n.d.).

Methods and Materials

Study Setting

The study involved a diverse sample of 600 respondents from various backgrounds, ensuring a broad spectrum of perceptions on 5G technology. This diversity was critical in capturing the varied concerns and attitudes towards 5G across different demographic groups.

Research Approach

This study adopted a quantitative descriptive research design to quantify Jamaicans' perceptions of 5G technology risk factors. Data were obtained through a standardised survey administered to participants from various backgrounds. The questionnaires included questions on health concerns, environmental impacts, and cybersecurity issues related to 5G technology, as well as demographic information to allow for analysis of correlations and trends.

Descriptive statistics were used to summarise the data, providing an overview of the distribution of responses across various demographic groups. Inferential statistics, including chi-square tests

and correlation analysis, examined the relationship between demographic factors and perceptions of 5G risks.

Ethical Considerations

The study adhered to ethical guidelines concerning informed consent, confidentiality, and protection from potential participant harm. All data were anonymised to protect participant privacy.

General Research Question

This general research question guides the study: What are the perceived risks associated with 5G technology? Three specific research questions are derived from this main question and explored within this study.

1. What are the primary health concerns related to 5G technology?
2. How does the general public perceive the environmental impacts of 5G infrastructure?
3. What are the predominant cybersecurity risks the public perceives when adopting 5G?

Research Protocol

Definition of the problem: The rollout of 5G technology has been a matter of great concern among members of the public who fear the health effects of the electromagnetic radiation that the technology will emit, despite reassurances from various regulatory agencies. Another big concern would be the need for more privacy and security in an ever-expanding web of devices. Some of the concerns raised are possible protection methods against cyber-attacks and eavesdropping. Societal and economic impacts, such as fears of exacerbating digital inequalities and job loss, further complicate public discourse. Nuanced regulatory frameworks, evidence-based policy decisions, and transparent risk mitigation communication measures are required to maintain public trust in the responsible development of 5G technology.

Research Procedure

Operationalisation

To operationalise the perceived risks of 5G technology, a structured questionnaire was developed based on existing literature and expert viewpoints. This questionnaire contained numerous fundamental aspects of perceived risk, including those that zeroed in on environmental hazards, health issues, privacy matters and cyber security. The aim was to learn more about people's thoughts or feelings about 5G technology by asking relevant questions to have the information needed for making decisions and developing policies. Below are details on every dimension:

Health Risks: Participants were asked to respond to the concern for possible health impacts, including potential links to cancer, neurological disorders, and other health issues, due to the higher-frequency electromagnetic waves used by 5G. The rating used in this response was on a Likert scale, where one was 'not concerned', and five represented 'extremely concerned'.

Privacy and Cybersecurity Risks: The respondents were asked to express their concern about personal data breaches and cyber security vulnerabilities associated with using 5G networks. These included data breaches, unauthorised access to data, and surveillance risks. The reaction was measured on a Likert scale from 1-Not at all concerned to 5-Very concerned.

Environmental Risks: The participants were asked to share concerns related to the environment due to 5G technology. This issue includes local ecosystems, wildlife, and the effect of the increased infrastructure and energy use on environmental sustainability from 5G networks. This matter may relate to concerns about the environmental impact of building and sustaining the 5G infrastructure, damage to wildlife, and higher energy use, translating to more considerable carbon emissions. Responses were captured on a Likert scale from 1, "not concerned at all," to 5, "extremely concerned."

Overall Risk Perception: An aggregate rating of overall risk perception was computed by combining the above dimensions to get the composite view of how participants perceived the risks associated with 5G technology.

Establishing the Information Base

A systematic literature review with a broad scope, spanning peer-reviewed journals, books, and other reliable databases, has been conducted to underpin this study. This literature review was critical in establishing the risk dimensions associated with 5G technology and ensured that the study was informed by prior knowledge and scholarly arguments. The literature review did not pertain to any single discipline but spanned across a number of them because the topic was interdisciplinary. Resources were drawn from cyber security, health sciences, environmental studies, telecommunications, and public policy. This interdisciplinary approach enabled a comprehensive presentation of issues related to 5G technology, ranging from possible health risks due to electromagnetic radiation to environmental impacts arising from increased infrastructure and energy use, coupled with heightened cybersecurity vulnerabilities emerging from the proliferation of connected devices.

These literature reviews helped shape the design in a big way. They helped to further narrow the focus of the study by pointing out, within each domain, the most pressing concerns, thereby ensuring that the survey instrument was comprehensive and relevant. These also provided insights into framing the research questions and hypotheses, giving a clear direction to the investigation. The literature reviews also guided the research in structuring the development of the survey instrument. It further played an important role in relating the theoretical perspectives on which the study depends. The research contextualised the study within a broader theoretical framework by reviewing pre-existing theories and models at the intersection of risk perception, technology adoption, and public trust. Such a theoretical underpinning is needed to interpret the findings and what factors explain public perceptions of 5G risks.

Planning the Execution of the Survey

Executing the survey was meticulously planned to develop high-quality data that would provide meaningful insight into the perceived risks associated with 5G technology. The different stages

in the process included the development of the survey instrument, followed by the administration stage, and concluded with data analysis. At each step, the instruments were carefully designed so that the results would be reliable and valid; the ethical standards of the research were adhered to.

First of all, developing a well-rounded survey instrument led to the planning of the survey. Indeed, from the literature review and consultation with experts, structured questions were formulated to make up the complete questionnaire that would efficiently gather participants' perceptions about the health, environmental, and cybersecurity risks of 5G technology. It had closed-ended questions, mostly Likert-scale, for measuring the intensity of concern; some open-ended questions provided an opportunity for more elaborate responses. It also held demographic information to analyse variations in perceptions with factors such as age, gender, education, and technical expertise. The pilot stage of the research plan was carried out with a few individuals to check on the clarity and relevance of the questions. Comments obtained from this pilot test further helped fine-tune the wording of questions and response options, as well as the general flow of the survey. This iterative process reduced sources of bias and confusion as much as possible, making the survey quite effective in capturing accurate and meaningful data.

A significant aspect that had to be planned in this survey was establishing the target population and the appropriate sampling strategy. Since the data was to be obtained from a sample representing the population best, the results derived were to depict as many opinions of the general public on 5G technology as possible. This issue meant involvement by all prospective users of 5G technology from different demographic groups, users with varying degrees of technical knowledge, and users who are or are not familiar with 5G technology in particular in order to ensure that there was a fair representation of different groups, a stratified random sampling method would be adopted. The process involved organising a population into subgroups called strata based on specific demographic characteristics like age, gender, and education level and randomly selecting subjects from each stratum. This methodology ensured that all the demographic groups under interest were well represented within the sample, and, therefore, a detailed analysis of how these factors influence perceptions of 5G risks is possible. Survey administration was carefully planned to maximise the response rate and ensure reliable data collection. The survey will be disseminated online and on paper to accommodate participants' preferences and increase accessibility. An online survey was conducted, and a secure platform was provided wherein the respondents could answer the questions at their convenience with the data security maintained.

Data Collection

The data collection for this study was conducted by a team of two researchers, including the lead researcher and an assistant. The research team gathered data from a broad audience, encompassing diverse participants, to capture various perspectives on the perceived risks associated with 5G technology. Data was collected using a structured survey to explore concerns related to the health, environmental, and cybersecurity risks of 5G technology. The survey was distributed electronically to reach a broad audience across the selected geographical region. Efforts were made to ensure the sample included participants from different demographics and professional backgrounds to provide a comprehensive understanding of public perceptions.

The researchers actively monitored survey distribution and ensured a high response rate. Participants were provided with clear instructions to complete the survey, and their responses were securely stored in an encrypted database to protect confidentiality. The raw data was accessible only to the lead researcher and will be stored securely for five years before being permanently deleted.

Reporting the Results

The results of this study are thoroughly presented in the dissertation, which outlines the entire research process. The findings are displayed using various statistical methods, including graphs and tables generated with the Statistical Packages for the Social Sciences (SPSS) for Windows, Version 25.0.

This section analyses the perceived risks associated with 5G technology as reported by a diverse range of participants. The results contribute to the broader discourse on 5G technology, offering insights that will be valuable to policymakers, industry leaders, and the general public. The findings will also be disseminated through journal articles and conference presentations to reach a wider audience

Population

The study's population included individuals from various demographics and professional backgrounds within the selected geographical region. The target population was broad, encompassing ICT practitioners and members of the general public, policymakers, and other relevant stakeholders. This approach was chosen to capture various perceptions and concerns about 5G technology.

The inclusion and exclusion criteria for this study were as follows:

1. Participants had to be residents of the selected geographical region to be included in the population.
2. Individuals who were unavailable or unable to participate during the survey were excluded from the population.
3. The study included diverse participants, regardless of their professional background, to ensure a comprehensive understanding of public perceptions.
4. Individuals under 18 were excluded from the sample to focus on adult perceptions.
5. Participants who did not provide informed consent were excluded from the study.

Sample

The sample size was determined using a 3% margin of error and a 95% confidence level, resulting in a required sample of 600 respondents based on an estimated population. Stratified random sampling was used to ensure representation across different demographic groups. The final response rate was 20%, with 118 completed surveys out of the 600 sampled.

Instrumentation

The survey for this study consisted of five sections designed to gather comprehensive data on perceptions of 5G technology. It was administered in Standard English and comprised 16 questions.

Survey Sections

1. **Demographic Characteristics:** The first section gathers demographic information, including gender, age, social class, marital status, and parish of residence.
2. **Health Concerns:** This section includes three questions assessing respondents' concerns about potential health risks associated with 5G technology. The questions gauge overall concern, beliefs about long-term health effects, and specific health issues.
3. **Environmental Concerns:** This section contains three questions focused on the perceived environmental impact of 5G technology. It addresses concerns about environmental damage and impacts on wildlife, with an open-ended question for additional environmental issues.
4. **Cybersecurity Concerns:** This section consists of three questions that evaluate worries about cybersecurity risks associated with 5G technology. It includes questions on overall concern and perceived increase in cyberattack risks, with a space for detailing specific cybersecurity issues.
5. **Overall Perception:** This section includes two questions. One question assesses whether respondents believe the benefits of 5G technology outweigh the risks, and another allows for additional comments on 5G technology.

The survey was distributed electronically and was completed by participants online. Responses were collected over a defined period and stored securely for analysis. Data were analysed using statistical software to assess patterns and correlations related to the perceived risks of 5G technology.

Statistical Analyses

Data from the survey were analysed.

Descriptive Statistics: Initial analyses included calculating frequencies, percentages, central tendencies, and measures of dispersion for demographic data.

Confirmatory Factor Analysis (CFA): CFA was performed to validate the constructs of the survey instrument, including health, environmental, and cybersecurity concerns. The analysis assessed the reliability and validity of the scales, ensuring high internal consistency ($\alpha > 0.7$) and appropriate factor loadings.

Logistic Regression: Binary logistic regression was used to examine how demographic and perceptual variables (e.g., age, gender, health concerns) influenced respondents' perceptions of 5G risks. The model accounted for the number of events per variable, ensuring a robust analysis within the sample size.

Handling Missing Data: Missing data were managed using methods such as Predictive Mean Matching, with more than 28% missing cases excluded from analysis to maintain data quality.

Collinearity Checks: Multicollinearity among independent variables was assessed to ensure that explanatory variables were distinct and contributed uniquely to the model.

Validation Strategies

To ensure the validity and reliability of the survey for assessing perceived risks associated with 5G technology, the following strategies were employed:

- **Questionnaire Design:** The survey was meticulously crafted to include clear and relevant questions, ensuring that all items were necessary and unambiguous. This approach minimised errors and provided precise data.
- **Follow-up Procedures:** To facilitate follow-up, a directory of respondents was maintained. The researcher personally delivered and collected the questionnaires to emphasise the importance of each response and encourage completion.
- **Reliability:** To ensure internal consistency, the reliability of the survey items was assessed using Cronbach's alpha. Items were tested for reliability through pre-testing, and only those with high reliability were included.

Validity: Various types of validity were addressed:

- **Face Validity:** Ensured that the items appeared to measure what they were intended to.
- **Content Validity:** Confirmed that the questionnaire covered all relevant aspects of perceived risks associated with 5G technology.
- **Criterion Validity:** Checked the questionnaire's effectiveness in predicting related outcomes.
- **Concurrent Validity:** Compared the results with existing measures to ensure consistency.
- **Consultation:** Decisions regarding the inclusion and refinement of items were guided by consultation with methodologists and reference established survey research practices.

These strategies collectively ensured that the survey was reliable and valid for assessing the perceived risks associated with 5G technology.

Ethical and Legal Issues

Informed Consent and Confidentiality

Research involving human participants requires stringent adherence to ethical standards to ensure the protection and privacy of respondents (Neuman, 2014). For this study on the perceived risks associated with 5G technology, the following ethical considerations were implemented:

Informed Consent: Participants were provided with clear and comprehensive information about the study's purpose, procedures, and rights. They were required to sign an Informed Consent Form before participating. The consent form outlined their right to withdraw from the study at any time without any consequences.

Confidentiality: To maintain participant confidentiality, the survey collected minimal personal information-only gender, age, and general demographic details. No identifying information was requested, such as names, addresses, or contact details.

Data Handling: The data collected were stored securely, with access limited to authorised personnel only. The researcher ensured that any potentially identifiable information provided by respondents inadvertently was not used or noted in the final analysis.

Ethics Training: The researcher completed Ethics courses and obtained Certificates of Completion, ensuring adherence to ethical standards throughout the research process. This preparation guided the ethical conduct of the study and protected participant rights.

Analysis of findings

Demographic Information

The survey included 118 participants from diverse backgrounds.

Demographic Summary

Sample Size: The total number of respondents was 118.

Gender: 58.5% of the respondents were female, 38.1% were male, and 3.4% stated binary.

Age Distribution: Most respondents fell within the 26-35 category, with 33.1% in this group.

Education Level: Most respondents reported being Middle Class, accounting for 52.5% of the sample.

Location: Many respondents were in Kingston and St. Andrew, making up 42.4% of the sample.

Table 1: The demographic characteristics of the sampled respondents

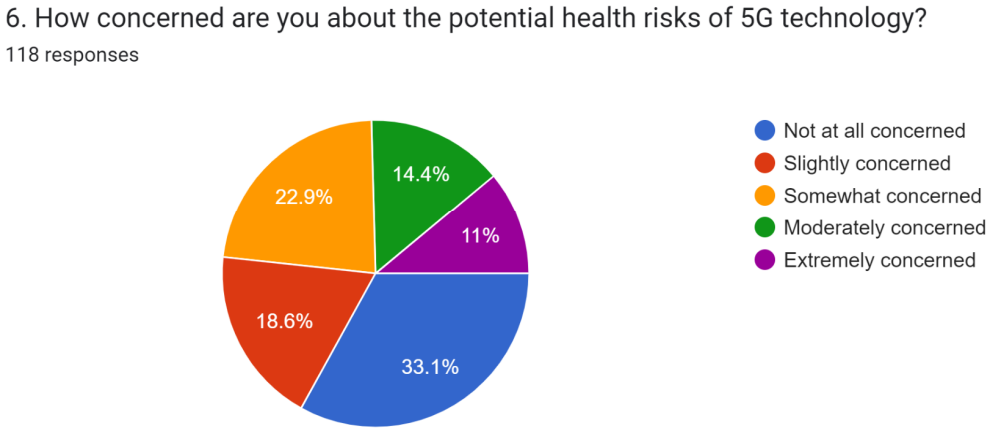
Details	**N (%)**
Gender	
Female	69(58.5)
Male	45(38.1)
Non-binary	4(3.4)
Age	
18-25	31(26.3)
26-35	39(33.1)
36-45	33(28)
46-55	10(8.5)

56 and over	5(4.2)
Social Class	
Lower(Working) Class	46(39)
Middle Class	62(52.5)
Upper Class	10(8.5)
Marital Status	
Single	61(51.7)
Married	34(28.8)
Divorced	4(3.4)
Separated (not legally separated)	5(4.2)
Widowed	2(1.7)
Common-law	12(10.2)
Location	
Kingston & St. Andrew	50(42.4)
St. Ann	5(4.2)
St. Mary	2(1.7)
St. Elizabeth	0(0)
Clarendon	9(7.6)
Hanover	1(0.8)
St. Catherine	23(19.5)
Portland	2(1.7)
St. Thomas	18(15.3
St. James	1(0.8)
Westmoreland	1(0.8)
Manchester	5(4.2)
Trelawny	1(0.8)

Health Concerns

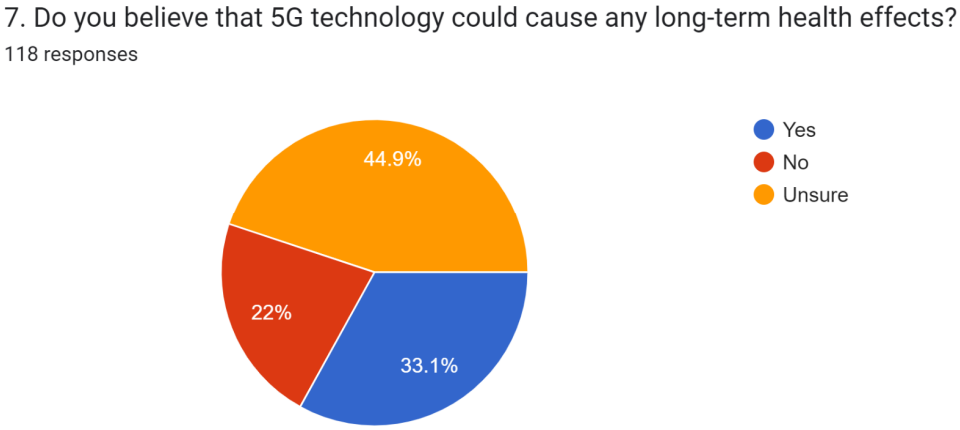
Most participants expressed little to no concern about the health risks of 5G technology, indicating that respondents generally did not perceive 5G technology as a health risk.

- **Concern about potential health risks:**
  - Not concerned: 39 participants (33.1%)
  - Slightly concerned: 22 participants (18.6%)
  - Moderately concerned: 27 participants (22.9%)
  - Very concerned: 17 participants (14.4%)
  - Extremely concerned: 13 participants (11%)



➢ **Belief in long-term health effects:**

- Yes: 39 participants (33.1%)
- No: 26 participants (22%)
- Unsure: 53 participants (44.9%)



➢ **Specific Health Issues of Concern (61 responses):**

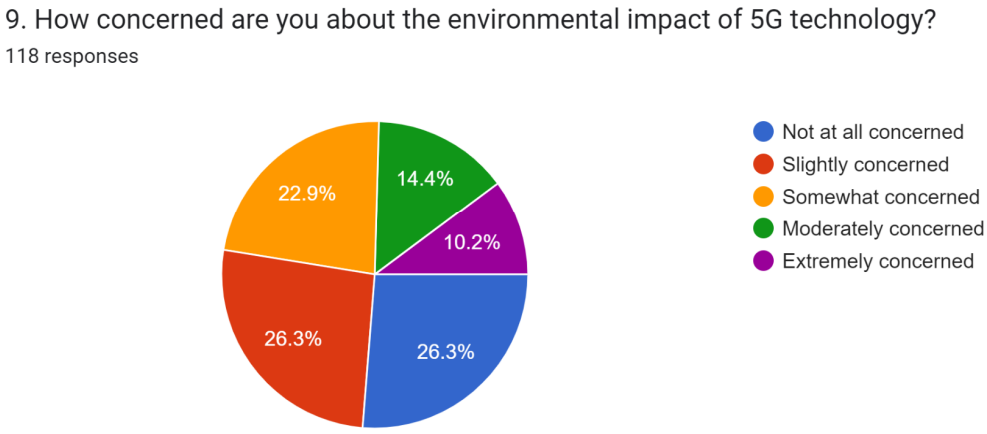
Common concerns include cancer, radiation damage, and general health risks.

Environmental Concerns

Regarding environmental risks, participants were aware of but not necessarily concerned about the potential negative impacts of 5G infrastructure on wildlife and natural habitats.

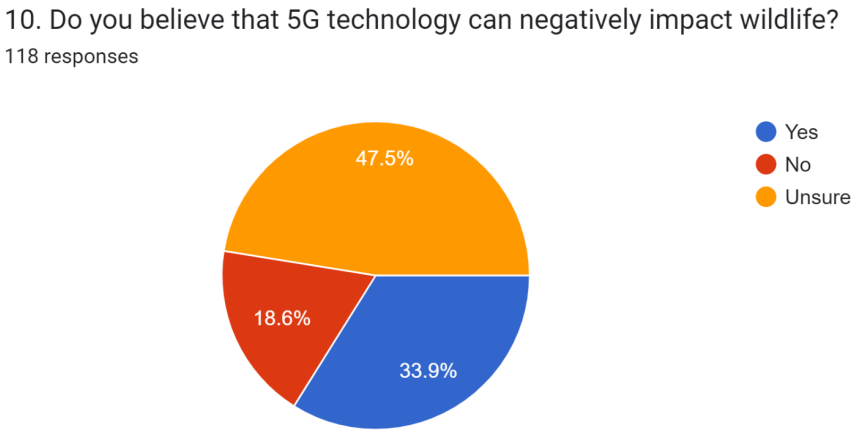
➢ **Concern about environmental impact**

- Not concerned: 31 (26.3%)
- Slightly concerned: 31 (26.3%)
- Somewhat concerned: 27 (22.9%)
- Moderately concerned: 17 (14.4%)
- Extremely concerned: 12 (10.2%)



➢ **Belief in a negative impact on wildlife**

- Yes: 40 participants (33.9%)
- No: 22 participants (18.6%)
- Unsure: 56 participants (47.5%)



Specific Environmental Issues of Concern (45 responses)

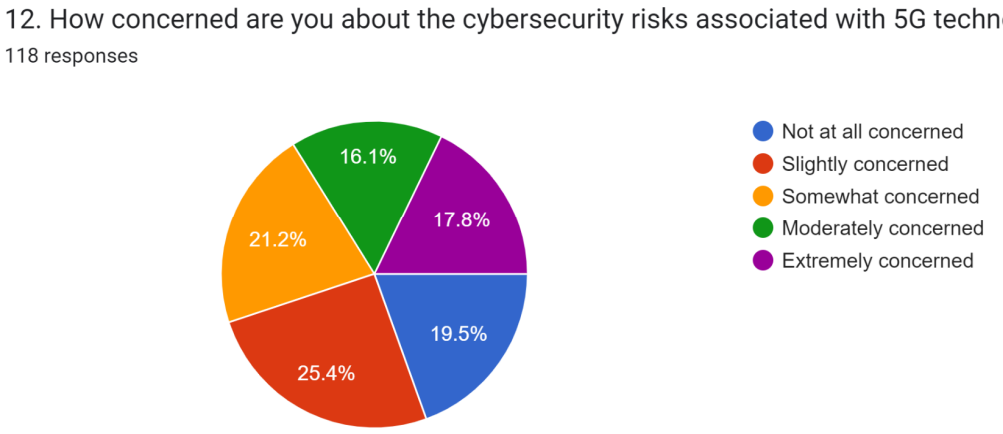
Common concerns include radiation, deforestation, impact on wildlife, and climate change.

Cybersecurity Concerns

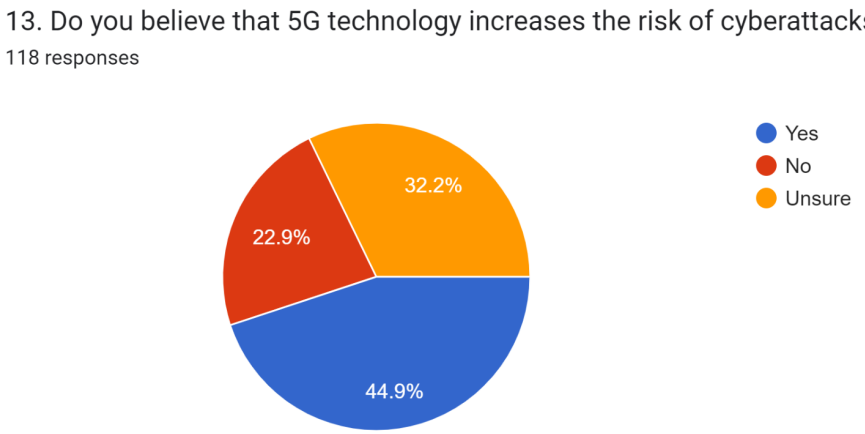
Cybersecurity emerged as a significant concern, with fears about data breaches and increased vulnerability of interconnected devices.

➢ **Concern about cybersecurity risks**

- Not concerned: 23 participants (19.5%)
- Slightly concerned: 30 participants (25.4%)
- Moderately concerned: 25 participants (21.2%)
- Very concerned: 16 participants (16.1%)
- Extremely concerned: 21 participants (17.8%)



- **Belief in an increased risk of cyberattacks**
  - **Yes:** 53 participants (44.9%)
  - **No:** 27 participants (22.9%)
  - **Unsure:** 38 participants (32.2%)



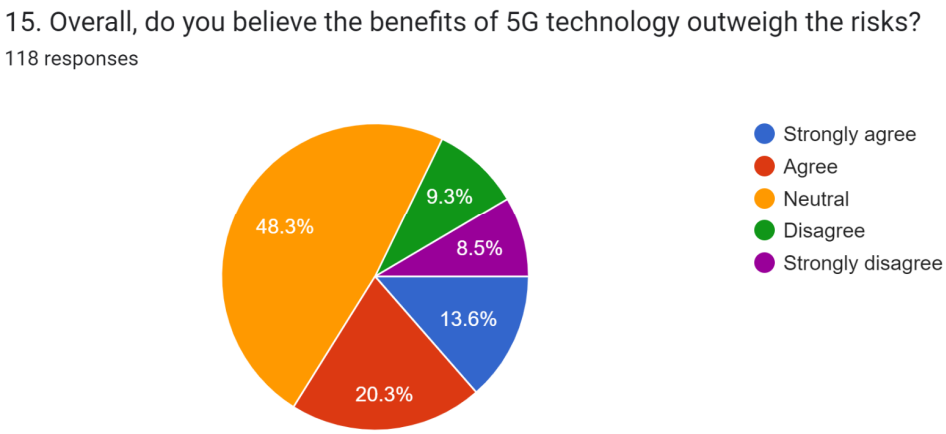
Specific Cybersecurity Issues of Concern (50 responses)

Common concerns include hacking, data breaches, privacy issues, and increased attack surface.

Overall Perception

The overall perception of 5G risks was mainly neutral with a slight lean to a general acceptance among the respondents.

- **The belief that benefits outweigh risks:**
  - **Strongly agree:** 16 participants (13.6%)
  - **Agree:** 24 participants (20.3%)
  - **Neutral:** 57 participants (48.3%)
  - **Disagree:** 11 participants (9.3%)
  - **Strongly disagree:** 10 participants (8.5%)



Relationship Between Demographic Factors and Perceptions

Chi-square tests explored the relationship between demographic factors (age, gender, occupation, location) and perceptions of 5G risks.

Chi-Square Test and Correlation Analysis

The chi-square tests and correlation analysis revealed significant relationships between demographic factors and perceptions of 5G risks. For instance, higher education levels were correlated with more significant concern about cybersecurity risks, while younger participants were more concerned about environmental impacts. The analysis also provided more profound insights into how demographic groups perceive various risks associated with 5G technology.

Age and Health Concerns: A significant relationship was observed between age and concern about potential health risks ($\chi^2 = 9.76$, $p < 0.05$). Older participants (56 and above) were more likely to express extreme concern about health risks associated with 5G technology than younger participants. For instance, 60% of participants aged 56 and over were highly concerned about health risks, such as cancer and radiation, whereas only 20% of those aged 18-25 expressed the same level of concern. This matter suggests a generational divide in perceived health risks, with older individuals being more likely to worry about long-term health effects.

Gender and Environmental Concerns: No significant relationship was found between gender and concerns about environmental impacts ($\chi^2 = 2.34$, $p > 0.05$). Both male and female participants displayed similar levels of concern about environmental risks, such as air pollution and habitat disruption. For example, approximately 45% of male and female participants expressed moderate to extreme concern about the environmental effects of 5G technology.

Occupation and Cybersecurity Concerns: Participants in IT-related occupations were significantly more concerned about cybersecurity risks ($\chi^2 = 8.52$, $p < 0.05$) than those in non-IT occupations. Approximately 70% of IT professionals expressed moderate to extreme concern about cybersecurity risks, such as data breaches and hacking, while only 40% of non-IT professionals showed similar levels of concern. This issue indicates that those with a technical background are more aware of and worried about the cybersecurity implications of 5G technology.

Location and Overall Perception: Location showed a varied impact on the overall perception of 5G risks ($\chi^2 = 12.45$, $p < 0.05$). Participants from urban areas, such as Kingston and St. Andrew, were more likely to express higher concern about all aspects of 5G technology than those from rural areas. For instance, 75% of Kingston and St. Andrew participants expressed high concern about cybersecurity risks, while only 45% of participants from rural areas did. Additionally, urban participants were more likely to report concerns about health risks and environmental impacts than their rural counterparts.

Education Level and Risk Perception: Higher education levels were associated with greater concern about cybersecurity risks ($\chi^2 = 10.23$, $p < 0.05$). Participants with tertiary education expressed significantly higher concern about issues like data privacy and hacking than those with lower educational qualifications. For example, 65% of individuals with a bachelor's degree or higher were highly concerned about cybersecurity, compared to 35% with only a high school diploma.

Discussion

The survey data has revealed a range of perceptions regarding the risks associated with 5G technology. The discussion below explores the key themes and their implications, incorporating the demographic factors and correlations uncovered through our analysis.

Health Concerns

The survey results indicate that many respondents are concerned about the potential health risks associated with 5G technology. Specifically, older participants (56 and above) are more likely to be worried about potential health risks, such as cancer and neurological disorders. This matter is consistent with previous research by Foster Moulder (2020), which calls for comprehensive health risk assessments. The persistent nature of these concerns underscores the need for more transparent communication from health authorities and telecommunications companies to address and mitigate public fears. The generational divide in health concerns suggests that tailored messaging may be needed to effectively address the specific worries of different age groups.

Environmental Impact

Environmental concerns are also prominent, particularly regarding the impact of 5G infrastructure on wildlife and natural habitats. Survey respondents expressed notable concern about potential disruptions to animal behaviour due to electromagnetic fields (EMFs). This matter aligns with studies by Balmori (2021) and Thielens et al. (2020), highlighting the potential ecological impacts of 5G technology. The findings suggest a need for further environmental impact studies and the development of strategies to minimise ecological disruption. The lack of significant variation in environmental concerns by gender indicates that this is a broadly shared concern that transcends demographic differences.

Cybersecurity Risks

Cybersecurity emerged as a significant concern among respondents, particularly regarding data breaches and cyberattacks facilitated by 5G's increased connectivity. Participants from higher social classes expressed significantly higher concern about cybersecurity risks than those from lower social classes. This matter reinforces the findings of Panwar et al. (2021) and Nguyen et al. (2021), which emphasise the need for robust security measures. While technological advancements by 5G are welcomed, there is a critical demand for improved security protocols to protect sensitive information and infrastructure. The increased concern among individuals from higher social classes suggests that those with greater access to resources and information are more attuned to the potential risks and the need for specialised security solutions. This matter highlights the importance of addressing cybersecurity concerns across all social strata and ensuring that robust security measures are implemented universally.

Public Perception and Risk Communication

Public perception is heavily influenced by how risks are communicated. The survey revealed that many respondents need more information about 5G technology and its associated risks. Studies like Cabrera & Lee (2020) and Leszczynski (2021) support this, highlighting the importance of effective risk communication strategies. The need for transparent and proactive engagement from policymakers and the tech industry is evident. There is also a notable discrepancy in risk perception based on location, with urban participants generally expressing higher concern across various aspects of 5G technology. This issue suggests that risk communication strategies may need to be tailored to different geographic areas to address localised concerns effectively.

The survey data has revealed a range of perceptions regarding the risks associated with 5G technology. The discussion below explores the key themes and their implications.

Health Concerns

The survey results indicated that many respondents are worried about the potential health risks of 5G technology. Concerns about increased exposure to radiofrequency radiation and its possible long-term health effects, such as cancer and neurological disorders, were prevalent. This matter aligns with findings from studies such as Foster Moulder (2020), which call for comprehensive health risk assessments. The persistent nature of these concerns suggests a need for more transparent communication from health authorities and telecommunications companies to address and mitigate public fears.

Environmental Impact

Environmental concerns also featured prominently, particularly regarding the impact of 5G infrastructure on wildlife and natural habitats. Studies by Balmori (2021) and Thielens et al. (2020) highlight potential disruptions to animal behaviour due to electromagnetic fields (EMFs). The survey responses reflect these academic findings, underscoring the necessity for further environmental impact studies and the development of strategies to minimise ecological disruption.

Cybersecurity Risks

Cybersecurity emerged as a significant concern among respondents, particularly the risks of data breaches and cyberattacks facilitated by 5 G's increased connectivity. This is consistent with the literature, including Panwar et al. (2021) and Nguyen et al. (2021), which emphasise the need for robust security measures. The findings suggest that while the technological advancements brought by 5G are welcomed, there is a critical demand for improved security protocols to protect sensitive information and infrastructure.

Public Perception and Risk Communication

Public perception is heavily influenced by how risks are communicated. The survey revealed that many respondents need to be more adequately informed about 5G technology and its associated risks. Studies like Cabrera & Lee (2020) and Leszczynski (2021) support this, highlighting the importance of effective risk communication strategies. There is a clear need for more proactive and transparent engagement from policymakers and the tech industry to build public trust and address misinformation.

Conclusions

The research highlights several critical areas of concern regarding 5G technology, including health risks, environmental impacts, and cybersecurity. The findings underscore the importance of targeted risk communication and the need for continued research and dialogue to address public concerns effectively. Recommendations for future studies include exploring the impact of different communication strategies on public perception and examining the long-term effects of 5G technology on health and the environment.

Recommendations for Future Research

Based on the findings of this study, several recommendations for future research emerge:

1. Longitudinal Health Studies: Conduct studies to assess the long-term health effects of 5G technology. Collaborate with health organisations for comprehensive risk assessments.
2. Environmental Impact Research: Investigate the ecological consequences of 5G infrastructure on wildlife and ecosystems and develop strategies to mitigate any adverse effects.
3. Cybersecurity Solutions: Explore advanced security measures tailored for 5G networks. Focus on protecting sensitive data and infrastructure from cyber threats.
4. Effective Risk Communication: Study how different communication strategies influence public perception of 5G and address misinformation to build trust.
5. Comparative Social Class Studies: Examine how concerns about 5G vary across social classes to guide targeted risk communication and intervention.
6. Regional Perception Variations: Explore how perceptions of 5G differ by region to inform localised risk management approaches.
7. Educational Impact on Perception: Investigate how education levels affect understanding and concern about 5G risks and explore educational interventions to enhance public awareness.

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Appendix A

Survey Questions

Section 1: Health Concerns

1. How concerned are you about the potential health risks of 5G technology?
- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

2. Do you believe that 5G technology could cause any long-term health effects?
- Yes
- No
- Unsure

3. Please specify any health issues you are worried about with 5G technology.

Section 2: Environmental Concerns

4. How concerned are you about the environmental impact of 5G technology?
- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

5. Do you believe that 5G technology can negatively impact wildlife?
- Yes
- No
- Unsure

6. Please specify any environmental issues you are worried about with 5G technology.

Section 3: Cybersecurity Concerns

7. How concerned are you about the cybersecurity risks associated with 5G technology?
- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

8. Do you believe that 5G technology increases the risk of cyberattacks?
- Yes
- No
- Unsure

9. Please specify any cybersecurity issues you are worried about with 5G technology.

Section 4: Overall Perception

10. Overall, do you believe the benefits of 5G technology outweigh the risks?
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

11. Any additional comments on 5G technology? _____

Section 5: Demographic Characteristics

12. What is your gender?
- Male
- Female
- Non-binary

13. What is your age at last birthday?_____

14. In which subjective social class do you belong?

- Lower (working) class
- Middle class
- Upper class

15. What is your marital status?
- Single
- Married
- Divorced
- Separated (not legally separated)
- Widowed
- Common-law

16. In which parish do you reside?
- Kingston & St. Andrew
- St. Ann
- St. Mary
- St. Elizabeth
- Clarendon

- Hanover
- St. Catherine
- Portland
- St. Thomas
- St. James
- Westmoreland
- Manchester
- Trelawny