

Crowdsourcing Cytogenetic Biodosimetry Dose Estimation Using The Dicentric Chromosome Challenge Game

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Introduction

In the case of a mass casualty event that is radiological or nuclear in nature, many individuals will require medical attention. Estimated radiation dose can guide medical professionals in taking appropriate medical measures to treat patients after a given exposure. The current “gold standard” of measuring dose is with Dicentric Chromosome Assay. While this method is highly effective, it is time-consuming, especially if many samples need to be analyzed. Automation is available for faster throughput, but this can give false readings requiring human correction. In such a case, many people would be needed to help make corrections. This research project sought to crowdsource this assistance by way of an online game called Dicentric Chromosome Challenge created by Oak Ridge Institute for Science and Education.

Background

- Ionizing radiation can cause several types of DNA damage.
- One event occurs when two chromosomes have been fragmented and are then fused, forming what’s called a “dicentric” chromosome as seen in Figure 1.
- Dicentric chromosome counts can be used with a calibration curve to determine estimated dose.
- Human verification and correction of the automated dicentric counting system may be feasible when crowdsourced via the Chromosome Challenge game, Figure 2.
- Playing the game requires clicking dicentric chromosomes, Figure 3.

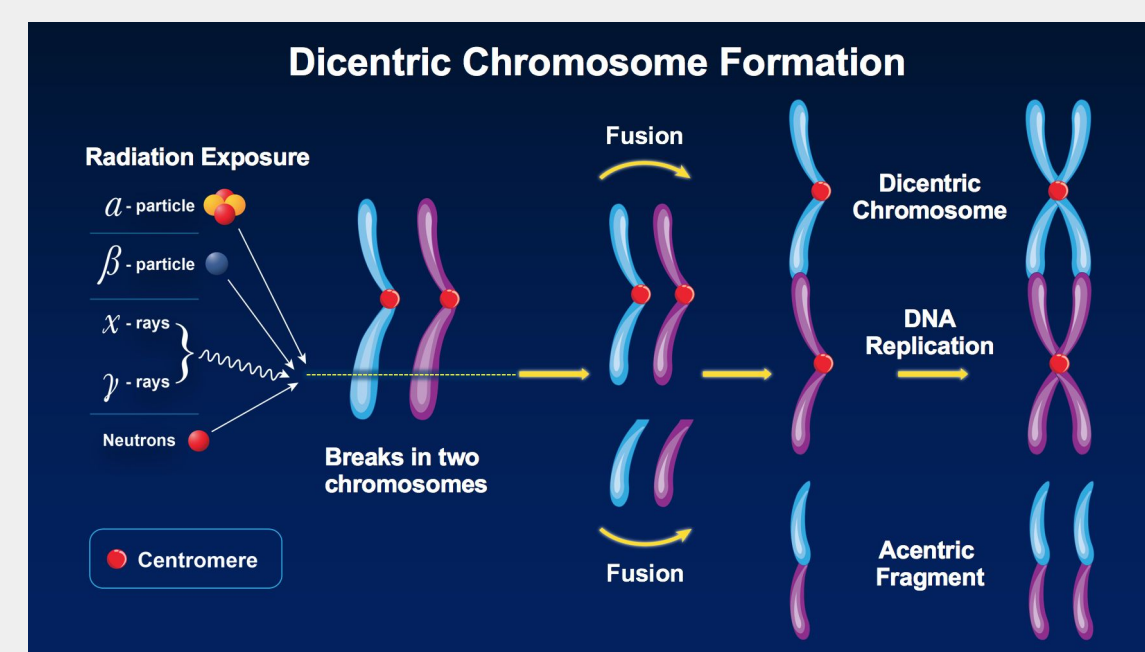


Figure 1. Dicentric chromosome formation due to ionizing radiation exposure.

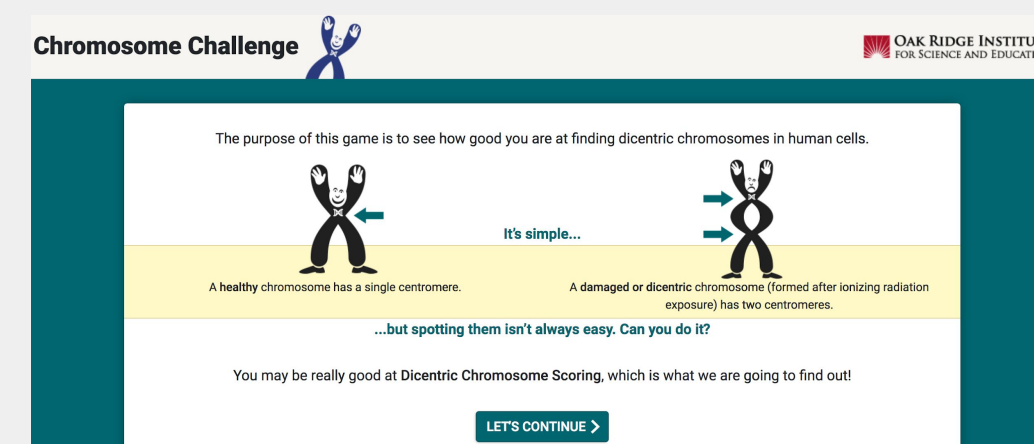


Figure 2. First educational page of the Chromosome Challenge Game.

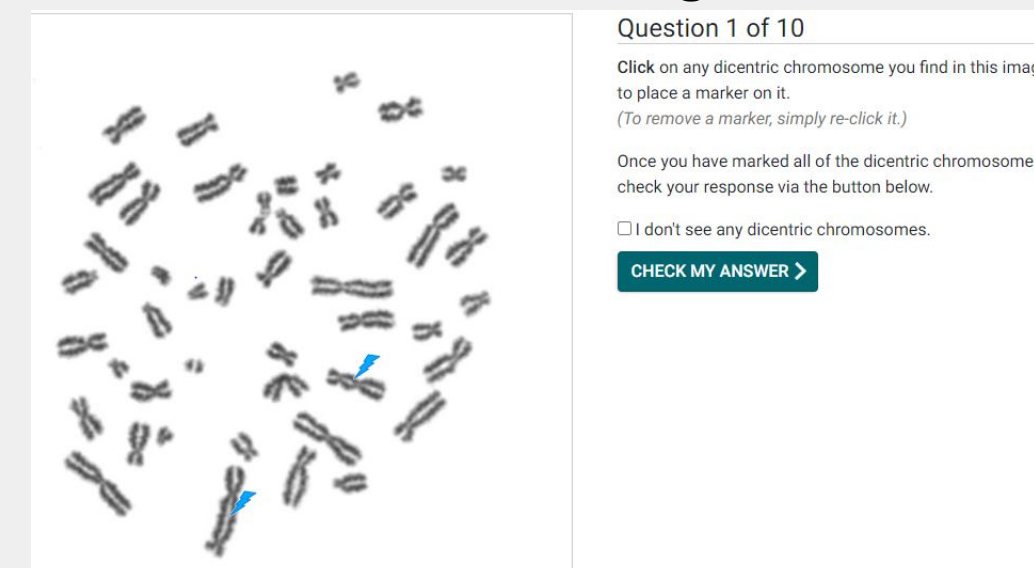
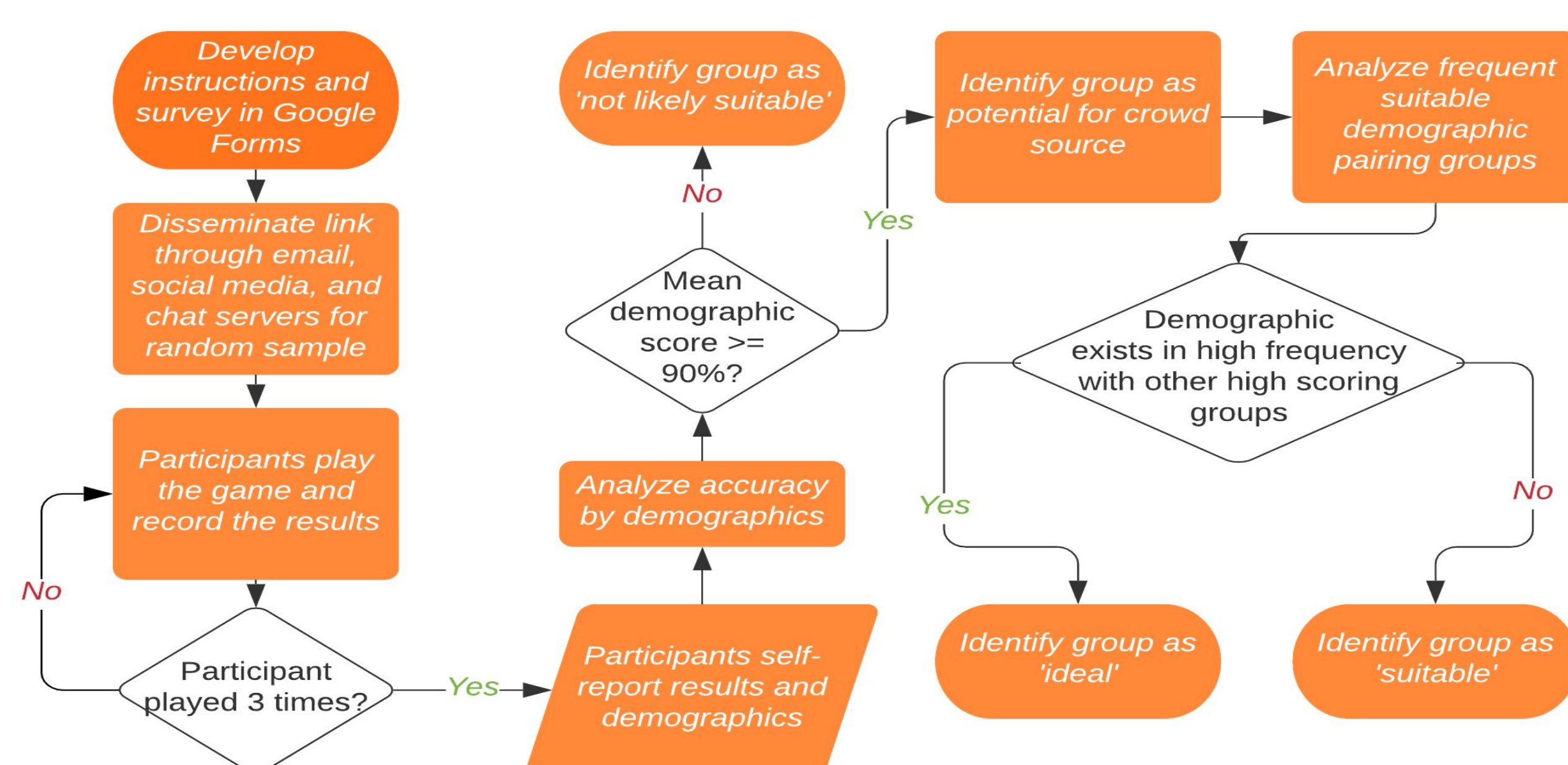


Figure 3. Example of game page with dicentric chromosomes chosen.

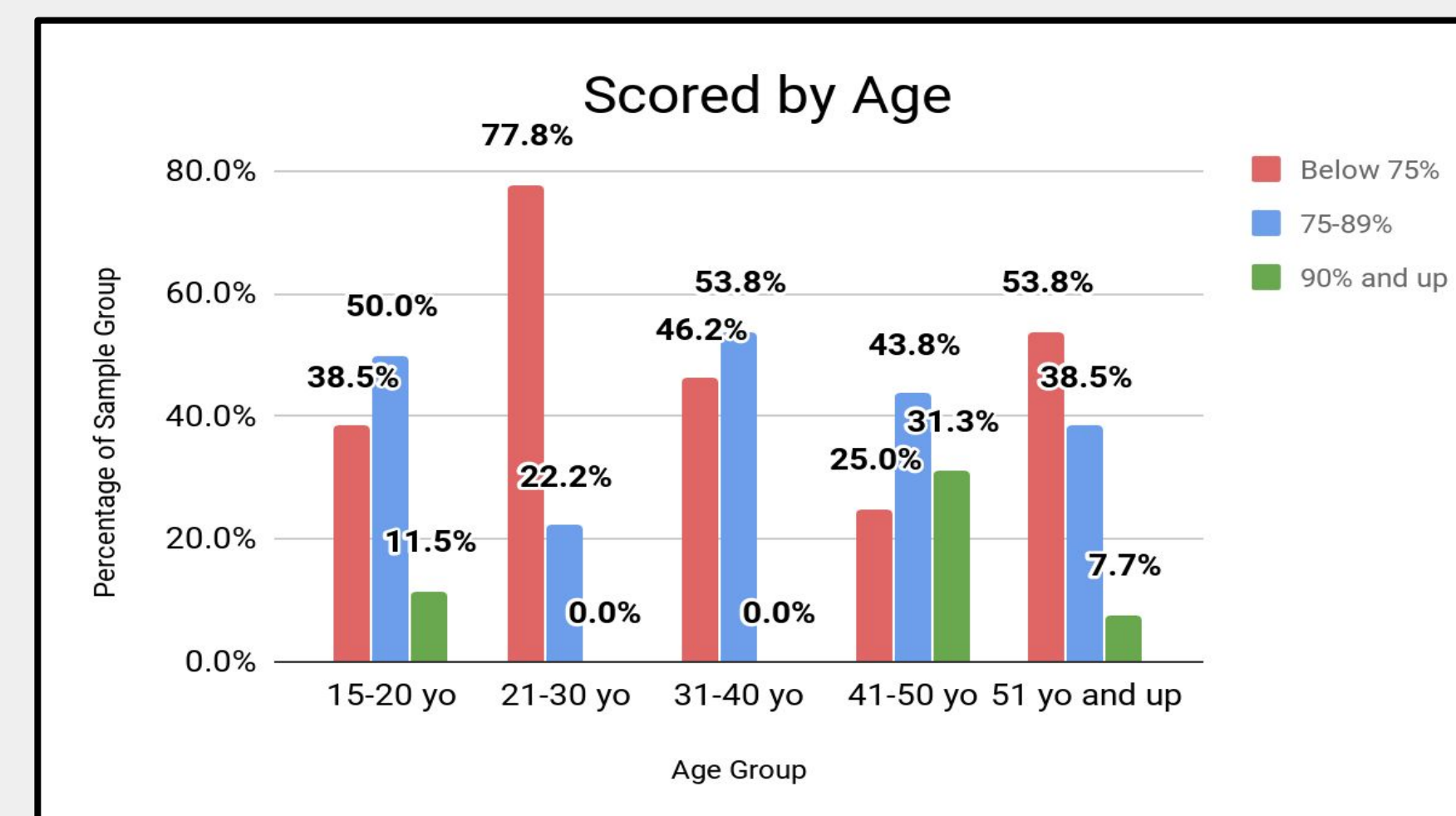
Materials and Methods

Materials: Dicentric Chromosome Challenge game, Google Form, Internet, Computer/Laptop



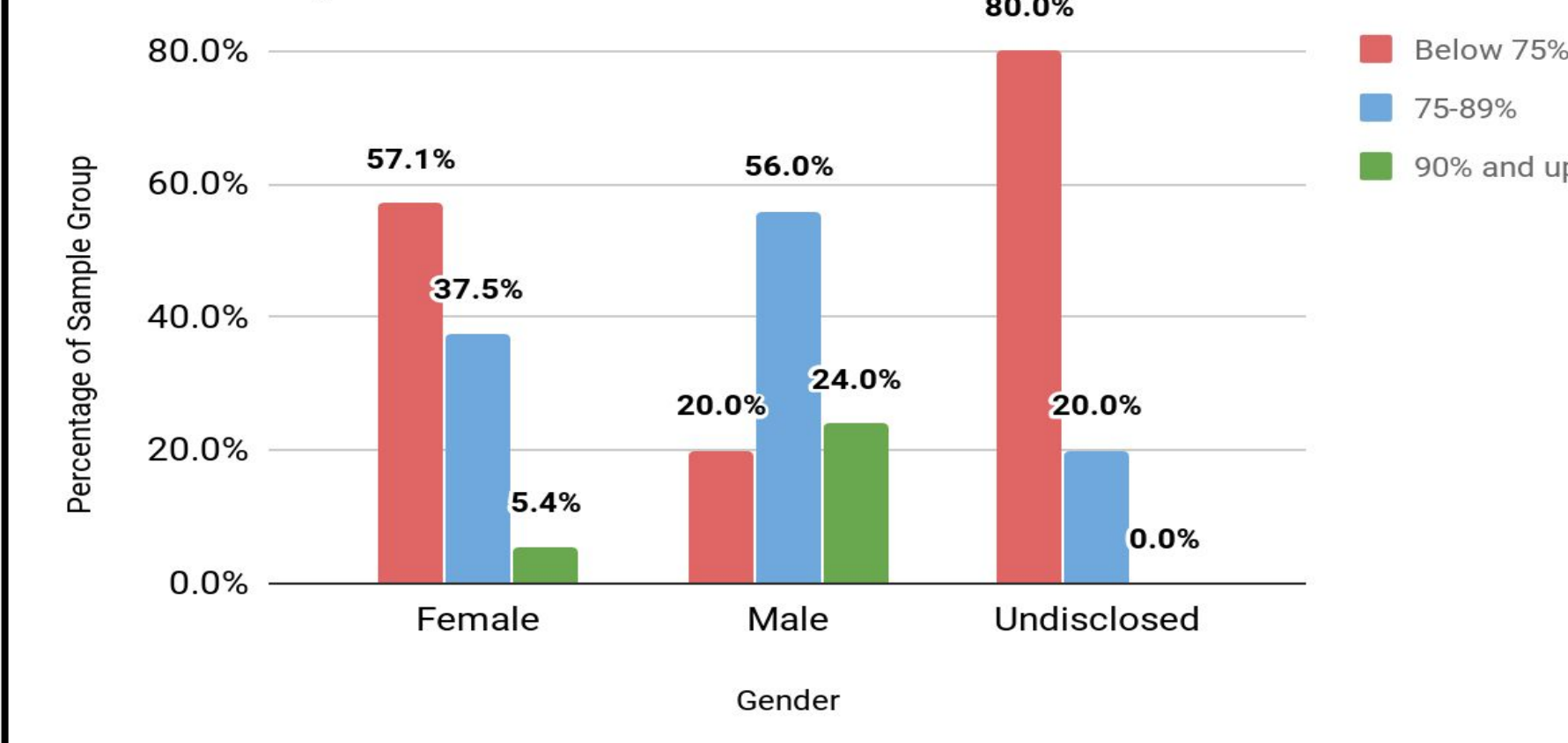
Results

Results are populated using data collected from 86 individuals.



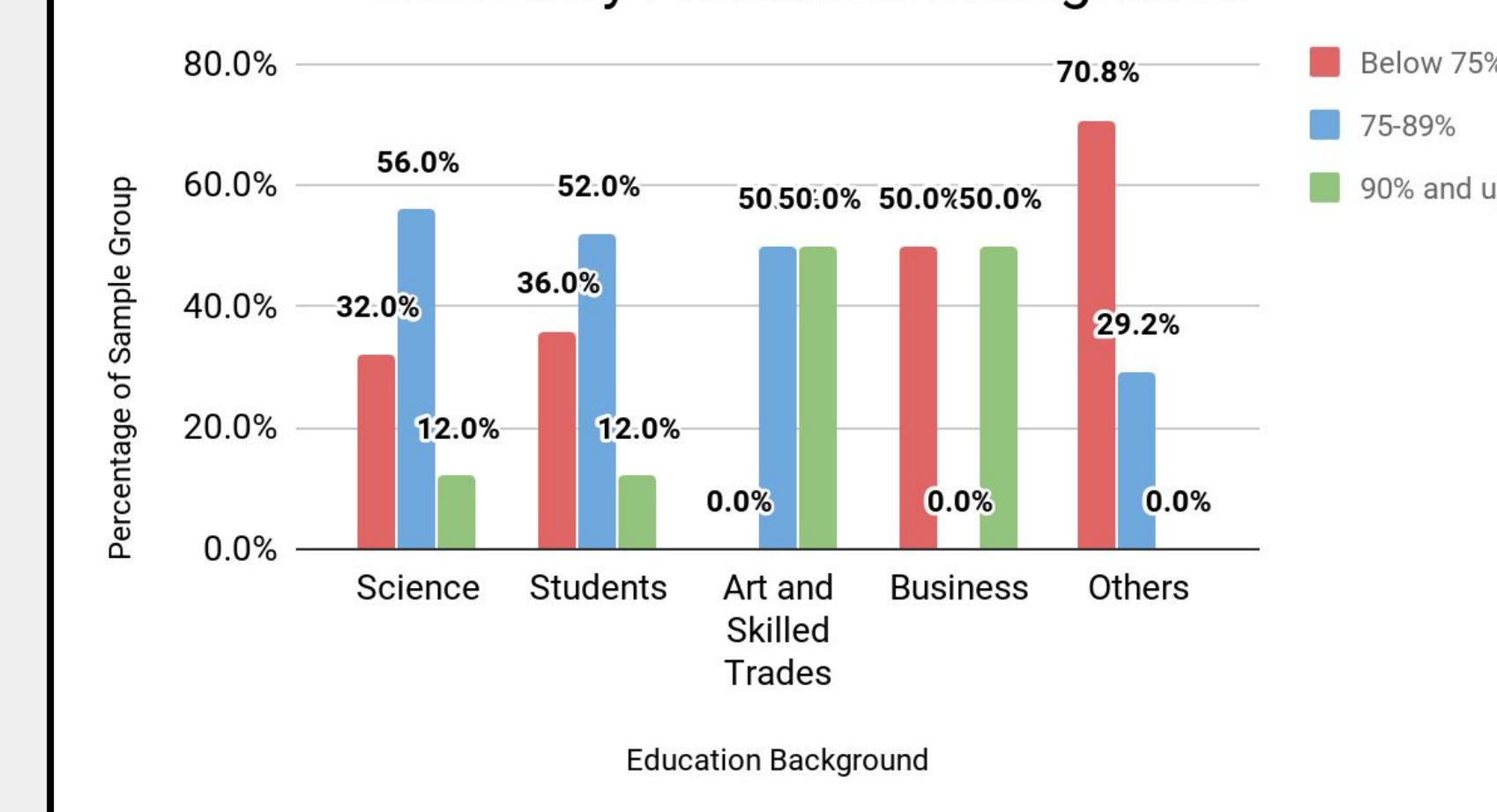
- 31% of individuals aged 41-50 scored 90% or above
- 12% of individuals aged 15-20 scored 90% or above
- Ages 21-30 and 31-40 had no desirable scores

Scored by Gender



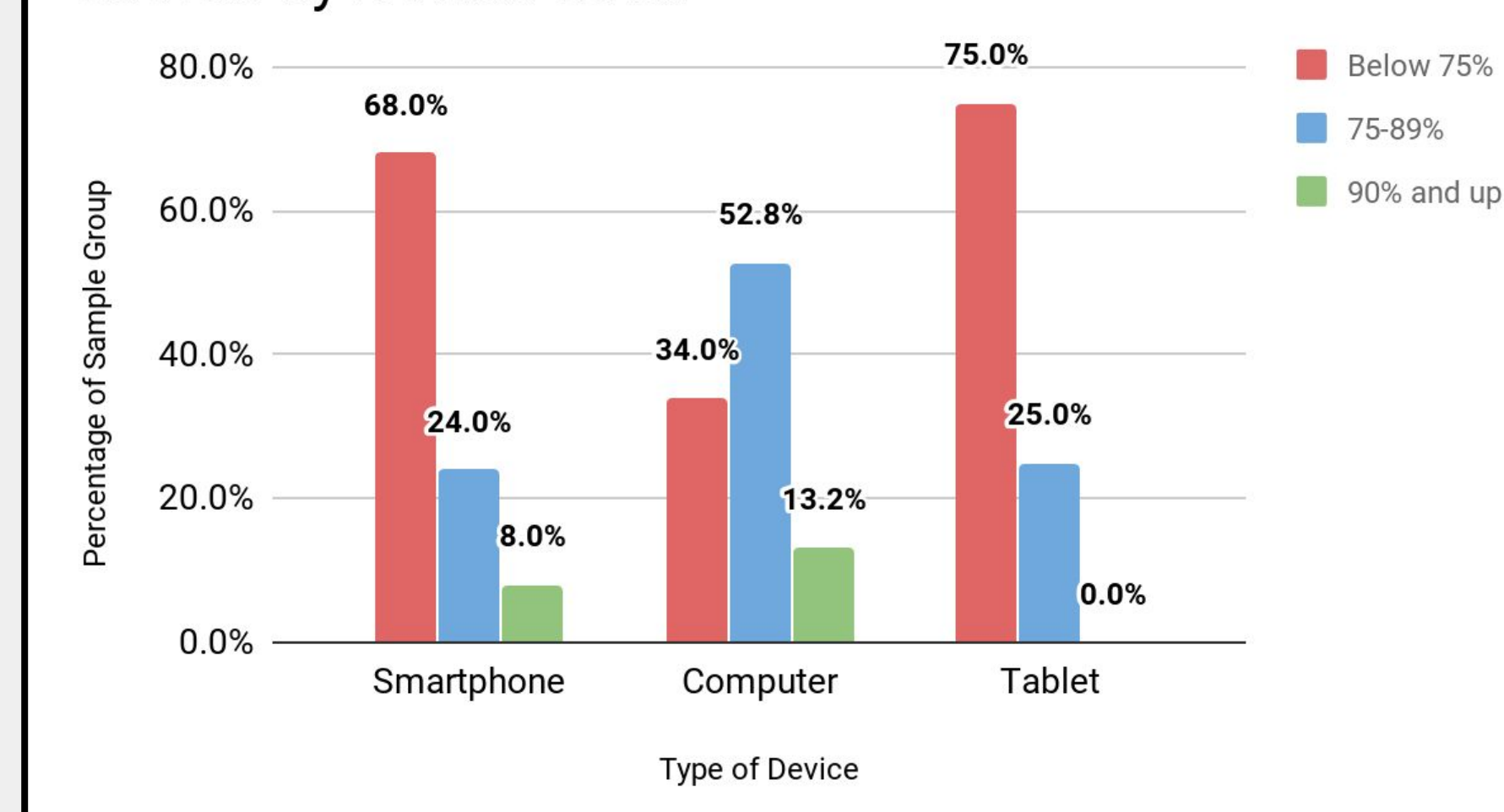
- Males had the highest success rate, with 24% scoring a 90% or above
- Only 5% of females scored a 90% or above

Scored by Education Background



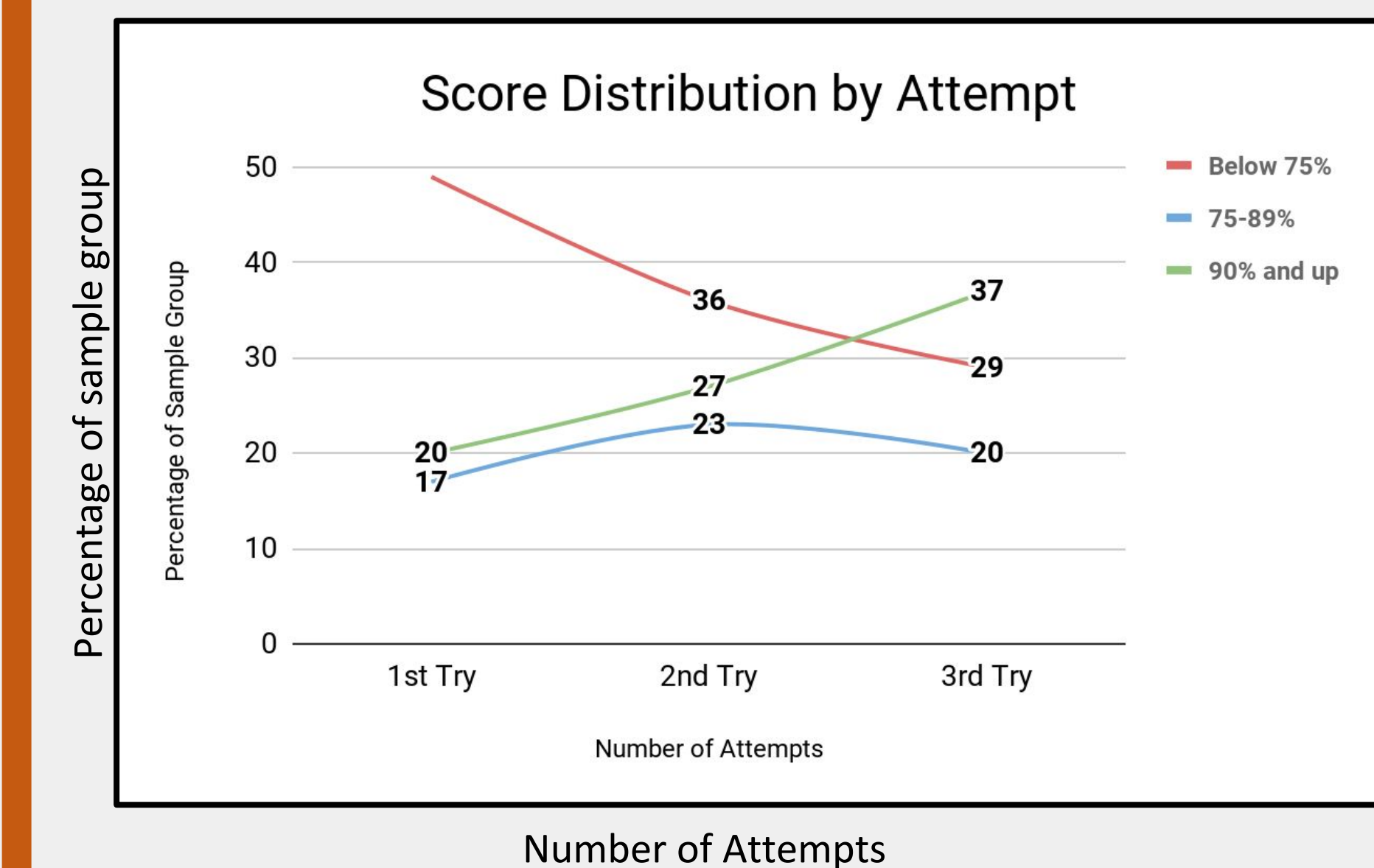
- Individuals with backgrounds in Arts, Skilled Trades, and Business had the highest success rates, with 50%
- 12% of both individuals with science backgrounds and students still in high school scored 90% or above
- No individuals aside from those with backgrounds in the aforementioned categories scored above a 90%

Scored by Device Used



- Individuals using a computer to play the game had higher overall success, with 13% scoring 90% or above and only 34% scoring below a 75%
- Tablet users had the least success with 0% scoring a 90% or above and 75% scoring below a 75%

Results Continued



- The number of individuals scoring 75% or below decreased as the number of attempts increased
- The number of individuals scoring 90% or above increased as the number of attempts increased

Discussion

Evidence suggests that crowdsourcing for cytogenetic biodosimetry dose estimation is feasible. Over the course of a week, data was collected and analyzed from 86 individuals. Based on this data, it can be concluded that the ideal volunteer can be discovered using the Dicentric Chromosome Challenge game. Data suggests the demographics of successful users tend to fall within the age range of 41-50 years old. Male participants scored higher than their female counterparts. Participants with backgrounds in business, arts, and skilled trades were ideal volunteers with the highest pass rates. Device appeared to play a role in success rate, with no tablet users scoring a passing grade. Computer users had the highest success rate when completing the challenge indicating that interface has a noticeable role in the scoring process.

Conclusions

Across all demographics, participants show a steady increase in accuracy, indicating that with practice, most participants could rise to proficient levels. This fact alone shows that the game achieves its goal and that future studies should focus on refinement of the interface and further general accessibility. In preparation of the potential event of a radiation mass casualty event, further development of this game would be beneficial to society as a whole to increase the number of eyes on the slides that could potentially overwhelm the current qualified workforce.

Acknowledgements

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References

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