

**Gender Disparity in Automotive Safety: A Care Ethics Analysis of the Design and Implementation of the Hybrid III 5<sup>th</sup> Percentile Female in Accident Simulations**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **Introduction:**

Women are much more likely to be severely or fatally injured in motor vehicle accidents and it is important to determine how the disparity formed. Crash test dummies, or anthropomorphic test devices (ATDs), assist in the prevention of injuries by simulating human bodies in dangerous situations. The Hybrid III crash test dummy family is a series of ATDs that model the mechanics and physical structure of the human body by reflecting geometry, weight, inertia, joint stiffness, and energy absorption (Nourreddine et al., 2002, p. 885). There is a model for a 50<sup>th</sup> percentile male, a 95<sup>th</sup> percentile male, and a 5<sup>th</sup> percentile female. The female crash test dummy was not based on a female body type, but rather it was a scaled down version of the already developed Hybrid III male crash test dummy. While it has been well established that the Hybrid III 5<sup>th</sup> percentile female crash test dummy is not representative of a female body and some scientists find it unsuitable to be used as an accurate predictor of female injuries in the event of an automotive crash, little investigation has focused on the ethical choices the design team made that lead to the creation of the Hybrid III Female. If the Hybrid III female design model persists in automotive crash tests without questioning the moral integrity of the designers, then the female population will continue to be provided inferior care as opposed to their male counterparts and further safety designs will be imbedded with bias. The Hybrid III 5<sup>th</sup> percentile female design team failed to act morally based on the conceptual framework of the ethics of care by failing to practice care responsibly and competently for female motor vehicle operators, consequently resulting in the perpetuated danger for women in automotive accidents. The ethics of care frames care as a social responsibility, that there is a duty to provide care to people. It is especially important to implement good care when there is an imbalance of power, when one group depends on the other to act in their best interest. The practice of care has four main ethical

elements in terms of the practice of care: attentiveness, responsibility, competence, and responsiveness (Tronto, 2020, p. 127). Using the main practices of care ethics as a lens to examine the discrepancies in female ATD anatomical representations and higher injury rates in female motor vehicle operators, this paper will show that the Hybrid III designers failed to act morally within the framework of care ethics.

### **Background:**

The first ATD was created in 1949 to test the safety of aircraft functions such as ejection seats, aviation helmets, and pilot safety harnesses (American Physical Society, 2011). Since the first model, different companies and organizations worked to evolve various ATDs based on the needs of the society. The Hybrid models were introduced as innovative technology, “with improved neck flexibility and head rotation to more closely simulate that of a human body” (American Physical Society, 2011). The main contributors involved in the creation of the Hybrid III model were the Society of Automotive Engineers (SAE) biomechanics subcommittees, First Technology Safety Systems, as well as Ohio State University (Humanetics, 2023, Hybrid III 5<sup>th</sup> female). The crash test dummies are helpful in that they provide a way to measure a human body’s reaction during a crash without endangering human lives. The Hybrid III model is a current tool in developing safety restraints that protect the user in automotive crashes (NHTSA, 2023, para. 1).

### **Literature Review:**

Extensive research has been done on the gender disparity within automotive safety, both within statistics of motor vehicle crashes and examining the accuracy of current crash test dummies; however, the ethical choices of female ATD design teams have not been thoroughly

investigated and held responsible for the implications and results imbedded within the implementation of their designs.

In *Vulnerability of female drivers involved in motor vehicle crashes: an analysis of US population at risk*, A team of PhD graduates investigated the statistical data of car crashes, attempting to find a discrepancy in safety based on the occupant's gender. Motor vehicle accidents are the leading cause of unintentional injuries that result in the highest number of fatalities, and women make up one third of the fatal crashes (Bose et al., 2011, para. 1). The research team took into account various factors such as number of miles traveled, crashes per mile, and proportion of crashes to fatal crashes, and found that although men were more likely to drive greater distances, female drivers had a greater proportion of fatal crashes; furthermore, it was discovered that female drivers wearing seat-belts were 47% more likely to sustain severe injuries (Bose et al., 2011, Results). Upon the uncovering of the disparity of safety, the team of researchers concluded that "health policies and vehicle regulations must focus on effective safety designs specifically tailored toward the female population for equity in injury reduction" (Bose et al., 2011, Conclusions).

Attempts have been made to create an updated model for crash test dummies. In a series of tests conducted in *Comparison of Hybrid III and THOR 5<sup>th</sup> percentile female dummies in frontal crash tests*, Jolyon Carroll and others examined experimental differences between the Hybrid III model and a newer dummy called the Test device for Human Occupant Restraint for 5<sup>th</sup> percentile females (THOR-5f) in frontal impact accidents. It was noted that the Hybrid III dummy was not designed for modern restraint systems and parts of the model do not accurately reflect its human counterpart (Carroll et al., 2021, 192). The National Highway Traffic Safety Association (NHTSA) acknowledged the limitations in the Hybrid III design and supported the

biomechanical research and development of THOR in order to provide better injury-detecting capabilities. Updated female features incorporated into the THOR-5f design include “female-specific features, such as integrated sternum and breast design to improve belt position and female-specific pelvic bone geometry” (Carroll et al., 2021, p. 193). The results of the experiment highlighted the complexity of ATD design, where further development of the THOR-5f crash test dummy is encouraged before fully replacing the Hybrid III 5<sup>th</sup> percentile model.

While statistical analysis proved the gender disparity of automotive safety and an attempt has been made to replace the current Hybrid III model for a more anatomically accurate female representation in crash test dummies, neither analysis emphasizes the foundation in which both research papers are rooted: that there was an underlying issue with the initial model that initiated gender inequality in automotive safety.

### **Conceptual Framework:**

Using care ethics to analyze the morality of the Hybrid III 5<sup>th</sup> percentile female crash test dummy design team highlights two ways in which the designers failed to act in an ethical manner. The conceptual framework of care ethics helps to define a moral structure that defines social responsibility within communities and relationships. According to political theorist and professor Joan Tronto, there are four phases of practicing care: attentiveness, responsibility, competence, and responsiveness (Tronto, 2020, p. 127). Attentiveness means that there is an awareness of the needs of others. Responsibility consists of being accountable for others’ needs. Competence refers to the act of providing good care to others. Responsiveness is defined by the reaction to provided care (Tronto, 2020, p. 127,131,133,134). These four distinct sections of the practice of care allow the conceptual framework to be used in order to determine whether an action could be morally sanctioned based on care ethics.

It is important to note the context in which care may be given or received. In cases where there is an asymmetrical distribution of power within a relationship, it is imperative that those residing with greater power extend their capability to protect those who do not have that same luxury. There is a duty of care to people, and when decisions for designs must be made, it is important that the creators understand the four phases of care in practice and ensure that they are implemented accurately.

The designers of the Hybrid III 5<sup>th</sup> percentile female crash test dummy failed to implement two key phases of the ethics of care framework, responsibility and competency, showing that they acted unethically in the release of their design. While the designers were able to gather from the population that half of it was unrepresented in terms of automotive crash test dummies and became aware of the needs of females to have preventative injury measures in the vehicles they drive, they failed to take care of the consumers of their product, and provided less than adequate care through their design choices, thereby creating a greater risk for females in automotive accidents. This paper will analyze the two failed phases of care in practice and address the relationship between care and power in relation to the Hybrid III ATD design team and the female users of motor vehicles.

**Argument:**

The Hybrid III 5<sup>th</sup> percentile female design team failed to meet two of the four main ethical elements according to the practice of care: acting responsibly and competently. Further, they failed to monitor the asymmetrical power dynamics in their design. It is inexcusable to take advantage of the vulnerability of an entire population depending on equal and fair treatment, and provide them with anything less. In the case of the Hybrid III female ATD, the designers recognized a lack of resources devoted to the prevention of female injuries in automotive

vehicles because there was the initiative to create a female crash test dummy. There was an understanding and awareness of the need for representation of a female anthropomorphic test device to be integrated into simulation to assist in the safety of females in a motor vehicle accident. Yet, the Hybrid III 5<sup>th</sup> percentile female crash test dummy design team ignored the needs of female motor operators, and in doing so, provided less than adequate care. The following sections analyze design decisions made by the Hybrid III design team to fully convey the extent of amoral actions that took place.

### Phase two: Responsibility

The Hybrid III design team did not take responsibility for its users' safety because there was never a 50<sup>th</sup> percentile female ATD created. Especially when there is an asymmetric distribution of power, it is extremely important for the groups with the ability to provide care to do so. The designers of the Hybrid III 5<sup>th</sup> percentile female ATD failed to take responsibility for the needs of average sized female motor vehicle driver even though the female population needed safety restraints with the same level of care given to them as to the male population. The 5<sup>th</sup> percentile female statistically means that only 5 percent of the female population is smaller than the female crash test dummy, whereas 95 percent of the female population is larger than the crash test dummy. The hybrid III crash test dummy family has three adult anthropomorphic test devices: a 50<sup>th</sup> percentile male, a 95<sup>th</sup> percentile male, and a 5<sup>th</sup> percentile female (Humanetics, 2023). There is an average sized male ATD to represent the middle of the population, with an equal balance of males who are smaller and males who are larger, a ratio of smaller to larger representation being 1:1. For women, the only ATD is the 5<sup>th</sup> percentile female, meaning that the ratio of representation is 1:19. For every one female that is smaller than the test dummy, there are 19 women that are larger.

The assumption for the design team for choosing those three ATDs as representative of the entire population because they covered a range of weights and heights, therefore seemingly covering both male and female motor vehicle drivers (Putka, 2021, “why crash tests”).

Table 1: Height and weight values of Hybrid III ATD models

<b>ATD Type</b>	<b>Seated Height (inches)</b>	<b>Weight (pounds)</b>
5 <sup>th</sup> percentile female	31	108
50 <sup>th</sup> percentile male	34.8	171.3
95 <sup>th</sup> percentile male	36.2	223.1

Using the range of height and weight of the ATDs in Table 1, the seated height ranges from 31 to 36 inches, and the weight ranges from 108 to 223 pounds (Humanetics, 2023, Product specifications). The average sized female in the United States is about 170 pounds (Marcin, 2020, para. 1). Therefore, based solely on the weights and seated heights, the population seems well represented including the average sized female. Men and women do not have the same mechanical structure, however, which makes the assumption inaccurate and leaves a large portion of the female population restricted by seat belts that are designed for men’s stature (Vanella, 2022, para. 3). The safety features implemented in automobiles geared towards women are based only on the 5<sup>th</sup> percentile ATD, and therefore the design team is only taking responsibility for those female occupants, not an average sized female. The 5<sup>th</sup> percentile female ATD weighs under 110 pounds and the relative standing height is 4 feet and 11 inches tall (NHTSA, 2023, 5<sup>th</sup> Percentile Adult Female). Those parameters of the ATD are roughly the size of a 12- or 13-year-old girl rather than corresponding to an adult woman (Putka, 2021, para. 2). The hybrid III design team did not create a 50<sup>th</sup> percentile female ATD; there was no model or

testing done for the average sized woman. Therefore, the design team failed to take responsibility for the population of females and did not act morally according to the second phase of practicing care within the care ethics framework.

### Phase three: Competence

Competent care was not provided to female motor vehicle drivers due to the negligence of the Hybrid III design team when they chose to create an anatomically inaccurate female ATD. For competent care to be incorporated correctly, the care provided should be good and successful in fulfilling the party's needs (Tronto, 2020, p. 133). The care provided by the Hybrid III design team to the female population does not meet a quality standard that would sanction their designs as good and successful care to female motor vehicle operators' needs. Of the population that the design team chose to provide care to, the 5<sup>th</sup> percentile of females, the actual design of the ATD was not representative of females with that stature. Although the relative body weight of a female is similar to that of the 50<sup>th</sup> percentile male ATD, the anatomical differences are also important in creating an accurate model to represent the female body in motor vehicle accident simulations.

The 5<sup>th</sup> percentile female ATD varies in very minor ways to its male counterparts. There is no mechanical variation to the female crash test dummy in relation to the male dummy. The 5<sup>th</sup> percentile female ATD is a scaled down version of the 50<sup>th</sup> percentile male (Humanetics, 2023, 5<sup>th</sup> percentile adult female). This design choice was a poor and inaccurate representation of female anatomy because the differentiation between men and women is more than breast tissue. Women are not simply smaller sized men, and therefore need an accurate ATDs that would be better able to predict injury in automotive accidents. Currently, women have a higher risk of injury to all major regions of the body, including head, chest, neck, and leg with 22.1%, 25.4%,

44.7%, and 79.9% greater risk respectively (Vanella, 2022, para. 1). The hybrid III models that car manufacturers base their safety around do not properly represent the population, and therefore lead to greater risk in female motor vehicle occupants.

The THOR-5F crash test dummy has taken a new approach to incorporate the variation in the “abdomen, arms, legs, sternum, pelvic bone, spine, neck, head and shoulders’ that would more accurately represent female anatomy” (Vanella, 2022, para. 4). The modifications create a more complex ATD with greater risk of damage to the technology during testing, but in comparison to the Hybrid III ATD, the THOR model was closer to PMHS results at all crash velocities, showing that it is possible to create a more accurate representation of female anatomy (Yoganandan, 2011, Conclusions).

By not creating an average female crash test dummy, the care provided to women in automotive crashes is limited to that of a 5<sup>th</sup> percentile female ATD. Furthermore, the fundamental anatomy of the female dummy is not representative of female anatomy and does not take into account numerous differences between men and women, so it was inaccurate and unfair to create a female dummy that was a scaled down version of the male counterpart. The design team acknowledged female motor vehicle user needs and provided a partial solution, however the crash test dummy created to address the safety concerns did not accommodate the average sized woman in the design and the risk of injury is higher for female drivers because of that design choice. The competency of care is therefore heavily decreased because good and successful care is not being provided to the female population.

### Asymmetric Power dynamic

There is a power imbalance between the design team and the driver of a motor vehicle in terms of safety because the user does not have a choice in the safety restraints implemented. When improper care drives the design features, women's safety is severely neglected. Women depend on the Hybrid III designers to provide good care because there is no other direct source of automobile safety. The only ones with the ability to implement a structurally accurate female crash test dummy are those on the design teams. The lack of ability to satisfy one's own needs forces every female motor vehicle operator to put their wellbeing in the hands of crash test dummy designers. They can only hope that the models accurately reflect their body, or else they will continue to be at greater risk of severe injury or death in the event of a crash. Popular crash test dummies consistently represent the average sized male and the 5<sup>th</sup> percentile female, it is never switched so that there is an average sized female model with a 5<sup>th</sup> percentile male scaled based on female anatomy (Humanetics, 2023, ATDs). This lack of arbitrary assignment to which gender is granted the foundation off of which other crash test dummies are built shows that there is an inherent vulnerability based on this approach of care. Female bodies are consistently underrepresented in modelling safety features.

When there are no crash test dummies that reflect the majority of the female population, it shows a negligence of caring for their needs. Design choices such as the idea to create the only female model on the 5<sup>th</sup> percentile of an adult female or the choice to simply scale down a male's body dimensions and mechanics and apply it to the female body with only minor modifications are concepts that only those in power have the ability to change. It is the duty of those in positions of power to ensure that care is properly and adequately provided to those who cannot provide the care to themselves. The Hybrid III design team has an obligation to every female motor vehicle operator to provide care because female operators cannot change the safety

measures of the vehicles they drive. The needs of female drivers were overlooked however, because people in positions of power did not sufficiently include tests models that represent the population.

Despite inequalities in female representation within crash test dummies when compared to the resources given to male safety, some members of the automotive community dispute the claim that women are more vulnerable in car accidents than men. Rather, their argument is that women have a higher risk of severe or fatal injuries because they tend to drive smaller and lighter automobiles (IIHS, 2021, para. 1). From a care ethics viewpoint, even if it were true that the disparity could be fully accounted for solely by the model of car being driven, it still does not absolve the Hybrid III designers in omitting a test dummy that represents a substantial portion of the population because the care provided is still prioritizing male safety (Tronto, 20202, p. 135). Care should not vary based on gender, and the argument that because there is no perceived variation in outcome does not justify the lack of resources and representation of female crash test dummies in safety regulations.

### **Conclusion:**

Based on the ethics of care conceptual framework, the Hybrid III 5<sup>th</sup> percentile female crash test dummy designers did not act morally because they failed three of the four ethical elements to provide good care for female occupants. There was an understanding for a need of a female crash test dummy, but the designers' choice in such a petite body size left a large majority of the population without adequate care, nor was there any focus on the lack of care. The awareness and acknowledgement of the needs of the population, without taking responsibility for them or providing competent care does little to show morally justified actions. The Hybrid III design team avoided taking responsibility for the female population's need of an equally safe

automotive vehicles despite the asymmetrical power relationship which forced the female population to be dependent on the design team to ensure their safety.

Furthermore, the designers' care, or lack thereof, was implemented into research which led to inadequate automotive safety features where female needs were neglected and treated as less important than their male counterparts, proving that good care was not within the scope of this design. It is important not only to understand and be aware of the higher vulnerability of female occupants in motor vehicles, but also to hold the design team accountable for perpetuating insufficient responsibility and competence in relation to care because it was a choice to create an unrepresentative female model. Average sized females were neglected when designing automotive safety features, and the overall design of the 5<sup>th</sup> percentile female was not an accurate model of female anatomy. The act of creating an unsuitable design is not morally acceptable based on the ethics of care conceptual framework. If a design team is not held morally responsible for the proper care of its consumers, then products will not always be in the best interest of the consumer, instead products will be subjected to the beliefs and biases of the designers.

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