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## THE EFFECTS OF EXOGENOUS VIRILIZING TESTOSTERONE ON STRENGTH TRAINING AND SELF-COMPASSION IN TRANSGENDER NONBINARY INDIVIDUALS

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THE EFFECTS OF EXOGENOUS VIRILIZING TESTOSTERONE ON STRENGTH  
TRAINING AND SELF-COMPASSION IN TRANSGENDER NONBINARY INDIVIDUALS

By

Nadine Sikora

THESIS

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In partial fulfillment of the requirements  
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SIGNATURE APPROVAL FORM

THE EFFECTS OF EXOGENOUS VIRILIZING TESTOSTERONE ON STRENGTH TRAINING AND SELF-COMPASSION IN TRANSGENDER NONBINARY INDIVIDUALS

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## ABSTRACT

### THE EFFECTS OF EXOGENOUS VIRILIZING TESTOSTERONE ON STRENGTH TRAINING AND SELF-COMPASSION IN TRANSGENDER NONBINARY INDIVIDUALS

By

Nadine Sikora

Previous exercise science research has excluded transgender nonbinary individuals from their studies. Exercise has been shown to improve symptoms of depression and anxiety as well as improve body composition. **Purpose:** Identify the impacts of exogenous testosterone on relative strength and levels of self-compassion in transgender nonbinary individuals. **Methods:** Eighteen untrained individuals (6 transgender nonbinary, 6 ciswomen, and 6 cismen, mean age of  $23.7 \pm 3.5$  years) were recruited and randomly assigned to an 8-week resistance training group or a non-exercise control group. Participants completed a 12-question survey of self-compassion followed by, assessment of strength for chest and leg press. **Results:** Data was analyzed using three-way (group x time x category) mixed ANOVA and effect size was reported as partial eta squared. There were no statistically significant results. Partial eta squared values shows high effect for chest press intervention and category (0.559 & 0.323). Levels of self-compassion & Category indicate low effect in the intervention ( $\eta^2 = 0.004$ ) effect and high effect within the category ( $\eta^2 = 0.295$ ). Regardless of gender, relative strength increased. **Conclusions:** Levels of relative strength may have had positive statistical significance with the inclusion of more participants due to the effect size seen. These results have implications suggesting further research is needed understand exogenous testosterone, to levels of self-compassion and relative strength.

**Key Words:** TRANS, MENTAL HEALTH, GENDER AFFIRMING CARE, PHYSICAL ACTIVITY, PILOT STUDY

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Nadine Sikora

2022

## DEDICATION

This thesis is dedicated to those looking for more answers for gender-affirming care as a comprehensive whole.

## ACKNOWLEDGEMENTS

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The author would like to thank all of the family and friends back in Canada (Brittany Farrish). Throughout the entire process of gaining knowledge through higher education, the path was a wild adventure full of chaos and excitement. During the hardest times, knowing that there was support back home helped keep the focus to succeed. Remember when I told you all I was going to go for 1 year to get certified as a personal trainer? I'm going to get a PhD instead.

Finally, the author must thank The Crib Marquette. The staff and regulars became family and an incredible support system. How else can one get through a thesis without witty banter at 7am over a cup of the finest coffee in the U.P. before camping out in the sun window upstairs to labor over this project? Thank you for the endless cups and full belly laughs.

This thesis was written in accordance to the guidelines of Northern Michigan University's School of Health and Human Performance and the American College of Sports Medicine's journal entitled Medicine & Science in Sports & Exercise (MSSE). The guidelines to this journal may be found at the link below:

<https://journals.lww.com/acsm-msse/ layouts/15/1033/oaks.journals/informationforauthors.aspx>

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***Figure 1:*** Illustrates the differences between conditions for each variable during pre-intervention, midway (week 4), and post-intervention (week 8)

## LIST OF SYMBOLS & ABBREVIATIONS

Transgender nonbinary.....	TNB
Ciswomen.....	CW
Cismen.....	CM
Hormone Replacement Therapy for Testosterone.....	HRT-T
Exogenous Virializing Testosterone.....	EVT
Resistance Training.....	RT
Short-Form Self-Compassion Questionnaire.....	SCS-SF
Non-exercising Control.....	CTRL
American College of Sports Medicine.....	ACSM
Subcutaneous.....	SC
Intramuscular.....	IM
Physical Activity Readiness-Questionnaire.....	PAR-Q
Submaximal one repetition max.....	1-RM
Bryzcki equation.....	$1 \text{ RM} = 100 * \text{load rep} / (102.78 - 2.78 * \# \text{ of repetitions})$

Rate of perceived exertion.....	REP
Analysis of Variance.....	ANOVA
Partial Eta Squared.....	$\eta^2$
Gonadotropin releasing hormone.....	GnRH
Hypothalamic-pituitary adrenal axis.....	HPA
Hypothalamic-pituitary-gonadal axis.....	HPGA
Luteinizing hormone.....	LH
Follicle stimulating hormone.....	FSH

## CHAPTER I: JOURNAL MANUSCRIPT

### Introduction

Transgender nonbinary individuals are disproportionately impacted by negative mental health and physical health outcomes likely attributed to disparities they face. In a nationwide survey conducted in 2022 capturing the experiences of LGB and/or T, researchers found 79% of transgender men experienced symptoms of anxiety and 69% experienced symptoms of depression (1). Anxiety has been negatively correlated with measures of self-compassion while researchers see positive correlation with exercise to levels of self-compassion (2,3). It has been reported that TNB individuals face many disparities including high levels of social rejection, bullying, transphobia and lack of support (4,5). With a higher risk for poor mental health and physical health measures, RT becomes an exercise modality of interest.

Resistance training has been shown to have numerous positive effects on mood state, depression symptoms, anxiety, muscle mass, bone mineral density, and endurance (1,6, 7). With a dose response to resistance training (RT), researchers believe training at <70% (low to moderate) of 1 repetition maximum (1RM) showing the greatest reduction in anxiety as seen in cisfemale and cismale participants aged 19-42 (2). Despite the known benefits of physical activity and RT as well as the risks of sedentary behavior, nearly 80% of American adults do not meet the general recommendations of 2-3 non-consecutive days of RT per week (8). According

to the Meyer minority stress theory, which suggests that LGB and/or T individuals have difficulty accessing physical fitness spaces due to discrimination (3). The minority stress theory (MST) states that LGB and/or T individuals suffer disparities to physical health when compared to heterosexuals. Similar to the ailments accompanying other forms of chronic stress, chronic minority stress is harmful to health and well-being (3). A barrier TNB individuals face that predisposes them to increasing levels of anxiety, depression and low levels of self-esteem is transphobia (1,3,4,5,9). Due to the varying levels of mood state in TNB individuals, it is difficult for some to engage in resistance training in public spaces.

It was previously thought that gender difference existed for strength among ciswomen (CW) and cismen (CM). Relative body size and muscle cross section area has also been found to show no significant differences among CW and CM (7). However, it can be expected that CW experience skeletal muscle growth and increase in strength at a different rate than CM (7, 10). To the best of our knowledge, no studies to date have compared relative strength increases of TNB with levels of self-compassion as measured by the Short-Form Self-Compassion Survey and submaximal strength testing, through a RT program.

Little is known regarding the impacts of exogenous virializing testosterone through Hormone Replacement Therapy and changes in relative strength and levels of self-compassion in the TNB community. Less is known about the association of resistance training for body related goals and self-compassion levels.

Therefore, the aim of this study was to examine the differences in relative strength and levels of self-compassion with the introduction of an 8-week resistance training protocol in all three gender groups represented. The research hypothesis for this study is that the relative strength measure in the TNB population on HRT-T will be similar to the rate of the CW and CM

counterparts with levels of self-compassion improving within the exercising group but remaining constant within the CTRL group over the 8-week intervention.

## METHODS

### Participants

Eighteen participants were recruited for this study. Transgender nonbinary, CW, and CM aged 18-40 were recruited, 6 were TNB (mean age =  $22 \pm 0.8$  years), 6 were CW (mean age =  $21.3 \pm 1.5$  years) and 6 were CM (mean age =  $25.9 \pm 3.9$  years). Parental administration of testosterone cypionate or enanthate varied for TNB, occurring every 1-2 weeks dependent upon individual HRT-T protocols.

Inclusion criteria were as follows: a) 18-40 years of age; b) self-reported activity levels did not meet the 2-3 non-consecutive days of RT per week as suggested by the American College of Sports Medicine (ACSM) within the last 6 months. transgender nonbinary participants were required to meet the following requirements; a) 6+ months of exogenous virializing testosterone (EVT) for HRT and b) HRT-T must be administered weekly or bi-weekly either subcutaneous (SC) or intramuscular (IM). Ciswoman were required to track their menstrual cycle to determine the phases for testing purposes. All testing for CW took place on day 14 ( $\pm 2$  days) of their menstrual cycle. All participants were age-matched across groups.

This study was approved by the Northern Michigan University Institutional Review Board committee. Diversity researchers within the university reviewed and approved of methodological design.

### *Procedures and Materials*

This study used a parallel study design, within, and between groups comparisons. This 8-week resistance training intervention examined the relationships between resistance training to self-compassion and levels of relative strength in the presence of EVT. Data collection test sessions occurred on three occasions, pre-intervention, mid-point (week 4  $\pm$ 3 days) and, post-intervention (week 8  $\pm$ 3 days). Participants completed preliminary questionnaires including; pre-screening digital intake form, Physical Activity Readiness-Questionnaire (PAR-Q), and Self-Compassion scale. Once completed, participants were randomly assigned to one of two main conditions: one condition performed RT 3 times/week, while the CTRL group was asked to continue their activities of daily living. The dependent variables were body mass, relative strength in the chest press and leg press, and levels of self-compassion. Additionally, participants in the RT condition reported pain levels upon arrival for their training each session. Experimental design can be seen in Figure 1. Participants were informed they could discontinue their participation at any point during the study.

### *Self-Compassion Scale*

Participants were asked to complete a 12-question questionnaire on levels of self-compassion called the Self-Compassion Scale Short-Form (SCS-SF). Developed by Dr. Neff, the SCS is a series of questions identify one's abilities to treat themselves with kindness rather than being harsh and self-critical. Participants began each testing session (pre-intervention, midway, post-intervention) by completing the SCS-SF in a private space. Upon completion of the questionnaire, participants were reminded of their voluntary involvement in the research project

and were again educated on the mental health resources available to them in the local region. Self-compassion indices have been linked to levels of anxiety.

The SCS-SF has been validated as an alternative to the valid 26-question version (1). This scale was created to represent thoughts, emotions, and behaviors as they relate to 6 subgroups; A) self-kindness, B) self-judgement, C) common humanity, D) isolation, E) mindfulness, F) over-identification (11). When calculating scores as a total mean, the SCS-SF shows near-perfect correlation with the original long form questionnaire ( $r \geq .97$ ). Participants were asked to indicate how often the statement aligns with their individual personal experiences. Responses provided are on a 5-point scale ranging from 0-5, with 0 being “Almost Never” and 5 being “Almost Always”. Total scores were represented as means. To score this scale, means for each subscale are calculated, then a grand mean is calculated to represent the overall score of self-compassion (11). Neff, included reverse scored items to avoid negatively worded questions. The SCS-SF is not validated as a tool for clinical significance. Instead, norms have been developed, scores between 1.0-2.49 are considered low, 2.5-3.5 moderate, and 3.51-5.0 high (10).

### *Submaximal Strength Assessment*

Estimated one repetition max (1 RM) was assessed to determine maximal dynamic strength using the leg press machine (Hammer Strength, Plate-Loaded Linear Leg Press, Los Angeles, CA, USA) and the chest press machine (Hammer Strength, Plate Loaded Iso-Lateral Bench Press, Los Angeles, CA, USA) performed in that order. Submaximal 1RM testing has previously been proven a reliable measure in untrained individuals (12). Prior to initiating the tests, each participant was familiarized with the process. Participants were instructed to perform 5 minutes of self-selected cardiovascular activity followed by a full body dynamic warm-up

guided by researchers. Participants completed their initial set of 10 repetitions at ~50% of their perceived capacity. Next, participants were given 2 minutes rest before the next trial with load increasing to ~80% of individual perceived capacity and asked to perform another 10 repetitions with proper form. If successful, participants load increased by 10.0-20.0% for leg press and 5.0-10.0% for chest press and continued further trials with a progressively increasing load. Once participants could no longer complete 10 repetitions with proper form, they were asked to stop. Final 1RM was determined within four trials with 2 minutes of rest between trials. Final load lifted is computed with number of repetitions completed and used in the Bryzcki equation for an estimated 1RM.

Bryzcki equation:

$$1 \text{ RM} = 100 * \text{load rep} / (102.78 - 2.78 * \# \text{ of repetitions})$$

\*(Where load rep was the final weight lifted at time of recording). (12)

### *Eight Week Strength Training Program*

The supervised RT group trained between 1600 – 1800 hours 3 times per week (Monday, Wednesday and Friday), over an 8-week period with a required an adherence rate of 80% during each stage of the study. The protocol was designed for hypertrophy in healthy populations to improve body related goals (6).

All three RT groups completed the same program using a combination of free weights, cable machines and body weight exercises. A non-exhaustive list of selected exercises within the RT program included; leg press, chest press, leg extension, leg curl, single leg deadlift, latissimus dorsi pull down, seated row, shoulder press, bicep curl, and triceps pushdown. Exercises were performed in 3 sets of 8-12 repetitions with a 2-minute rest between sets. Load

was initially set at 65% of calculated 1RM for tested exercises (leg press and chest press) and progressively increased to 80% of 1RM. Adjustments to load was made using self-reported rating of perceived exertion (RPE) using the Borg scale. An example of the RT protocol can be in the appendices.

### *Analysis*

Twelve participants completed the study and were included in the final analyses. A three-way mixed ANOVA was performed for each dependent variable to determine the effect of the RT and CTRL conditions over three time points: pre-intervention, mid-point, post intervention between TNB, CW and CM. Data collection and testing occurred pre-intervention, at the midpoint (4 weeks), and post intervention (8 weeks), occurring between 1600 and 0800 hours. Additional data were analyzed for the SCS-SF using a mixed ANOVA across TNB, CW, and CM within respective intervention groups (RT or CTRL). A Mauchly's test of sphericity indicated the data were normally distributed for each dependent variable. For interpretation of the magnitude of the differences, partial eta squared ( $\eta^2$ ) effect size was used. For our study, a  $\eta^2$  of 0.01 indicates a small effect; 0.06 indicates a medium effect, and 0.14 indicates a large effect (13). Significance was accepted at an alpha level of  $p \leq 0.05$ , and all data are reported as mean  $\pm$ Std. D. All analyses were performed using IBM SPSS, version 25.

## RESULTS

Figure 1 summarizes our experimental design. Our recruitment efforts produced 62 respondents interested in participation. Of these, 44 did not meet inclusion criteria or did not present on testing session days. Final participation included 18 participants (TNB n=6, CW n=6, CM n=6) before randomization into two interventions, RT or CTRL. Due to unrelated injury or illness, 6 participants dropped out of the study. Statistical analyses involved 12 participants, 5 RT (TNB n=2, CW n=2, CM n=2) and 7 CTRL (TNB n=2, CW n= 2, CM n=2).

### Descriptive Data

Primary outcomes were self-compassion measured by the SCS-SF and relative strength. Table 1 presents descriptive statistics of the intervention on outcomes of self-compassion and relative strength. Means and standard deviations are represented within the table for self-compassion with the highest score one can achieve being 5

Representation of relative strength was done so through determining the ratio of predicted 1RM and displayed as percent relative to one's mass on testing day, using the following equation: (kilograms lifted) / (body weight). Relative strength means for the LP are displayed in Table 2.

As shown on Table 3, there was no statistical significance to increases in relative strength for chest press among category groups or RT/CTRL conditions. The  $\eta^2$  for category and

intervention ( $\eta p^2 = 0.323$  and  $\eta p^2 = 0.559$  respectively) indicated a strong effect. The  $\eta p^2$  indicates the intervention could have high effect, though it was not statistically significant when examining relative strength changes in the leg press ( $\eta p^2 = 0.526$ . Changes in relative strength to leg press showed no statistical significance with effect of  $\eta p^2 = 0.129$ ). Conversely, no statistically significant increases were seen among RT and CTRL interventions. The  $\eta p^2$  for category and intervention ( $\eta p^2 = 0.323$  and  $\eta p^2 = 0.559$  respectively) indicated a moderate effect. These results suggest potential for better statistical analysis with a larger sample size.

## DISCUSSION

The purpose of this study was to determine if there were any changes in self-compassion, before, during and after exercise intervention in TNB on EVT, CW, CM, as well as non-exercising control groups. These variables, as shown in Table 1, are measured across three main time points: pre-intervention, midway (week 4), post-intervention (week 8). Additionally, this study sought to determine the similarities or differences between gains of relative strength in all groups (TNB, CW, and CM).

The results of this study indicated there was an increase in relative strength in all participants, although not statistically significant, after 8-weeks of a structured RT program. However, not statistically significant, when considering the results of partial eta squared with respect to gender, results have potential for statistical significance, but that theory must be tested in future research. Conversely, the RT program had low effect suggesting there was little to no impact on levels of self-compassion as a result to RT. However, when examining Figure 2, levels of self-compassion remain elevated above the CTRL, further demonstrating exercise improves mental states. Much of current research examines the impacts of aerobic activity on measures of anxiety, depression, mood, self-esteem and cognitive function (14). When researchers Pérez-Aranda et. al., examined the interaction of anxiety to self-compassion, they found a significant correlation between the two. However, those same measures have not been studied as thoroughly

in resistance training interventions (15). These results suggest a similar link to improvements in mental health with structured resistance training protocols.

This data does not support self-compassion levels being impacted through exercise. Self-compassion was only measured on three separate occasions not capturing a good representation of mental state over the course of an 8-week period. Measures of self-compassion decreased slightly regardless of intervention only within the CW population over the 8-week period. While the decrease in levels of self-compassion were seen to be minimal, there is a larger decrease in self-compassion levels in the CTRL group. Coupling these findings with the increase in self-compassion within the CM RT group being higher than the CTRL group confirms findings of improved mental health in exercising groups (2,3,7,14). The data presented however, does provide preliminary results suggesting a need for further research to capture a better understanding of individual levels of self-compassion in conjunction with RT.

This study also examined whether any changes in relative strength would occur differently across groups (TNB, CW, and CM). Effect size represented through the partial eta squared value indicates a strong potential for statistical significance to increase in relative strength for chest press and leg press. However, initial analysis showed no statistical significance in relative strength for the intervention or the interaction within the varying groups. Table 2 shows the means of CP and LP as well as percent change from the first testing session to the last. The results of tests of relative strength were mixed. Within the CTRL groups, measures of relative strength increased beyond that of an exercising participant. The results indicated no significance to self-compassion through an 8-week RT program. In figure 2, relative strength within the RT groups shows a more linear increase over time while the CTRL group had more drastic variations. It is typical to see linear improvement with a RT program utilizing progressive

overload techniques (6). However, it is difficult to come to a scientific conclusion explaining the drastic increases in relative strength within the TNB in the CP and CM in the leg press.

## CONCLUSIONS

The hypothesis that the introduction of HRT-T coupled with RT would increase strength and levels of compassion at a greater rate than the CTRL intervention was not supported. However, strength did increase across all groups regardless of intervention. Due to several limitations being present, this study will continue to evolve and provide valuable information and data to researchers. Through individual verbal feedback, 100% of TNB participants, including the CTRL group, continued or began routine resistance training. These participants are actively working towards their individual body related goals. Through the design of the RT program, participants were given autonomy to continue training as the study concluded to encourage healthy behaviors. This information highlights the need to improve support for TNB to engage in physical activity. The lack of significant differences in relative strength gains or self-compassion could be due to a small sample size. The familiarization effect could have occurred during this study, particularly in the CTRL group. In future studies, it would be suggested to begin with a familiarization relative strength test session prior to data collection. Future research should focus on recruiting a larger sample. Additionally, RT did not have statistical significance to support RT improving self-compassion. One might infer the lack of improvements in levels of self-compassion may be explained in part due to the demands of student life in higher education as well as the COVID-19 pandemic fatigue felt by many (5,16).

## Tables and Figures

**Table 5:** Descriptive statistics from three-way repeated-measures ANOVAs for dependent variables; self-compassion and relative strength for chest press and leg press. Showing means and standard deviation for each variable organized by condition

SCS-SF	Test Session	TNB		CW		CM	
		Mean	Std. D.	Mean	Std. D.	Mean	Std. D.
Resistance Training	Pre	3.13	0.88	3.25	0.00	3.00	0.47
	Mid	3.25	0.47	3.08	0.00	3.17	0.35
	Post	3.29	0.76	3.00	0.00	3.42	0.69
Control	Pre	3.13	0.18	3.38	0.42	2.72	0.54
	Mid	3.05	0.88	3.17	0.47	3.33	0.00
	Post	3.71	0.88	2.96	0.65	2.94	0.55

### Relative Strength

CP	Test Session	TNB		CW		CM	
		Mean	Std. D.	Mean	Std. D.	Mean	Std. D.
Resistance Training	Pre	.6235	.14526	.2500	.00000	.5634	.21898
	Mid	.6732	.09785	.4673	.00000	.7507	.17729
	Post	.7345	.09736	.6567	.00000	.8570	.13605
Control	Pre	.4310	.03049	.3229	.04064	.6810	.25662
	Mid	.5831	.20936	.3762	.08587	.7767	.30667
	Post	.5434	.16897	.3985	.03162	.7833	.35192
LP	Test Session	TNB		CW		CM	
		Mean	Std. D.	Mean	Std. D.	Mean	Std. D.
Resistance Training	Pre	2.09	0.64	2.11	0.00	1.90	0.25
	Mid	2.51	0.88	2.22	0.00	2.77	0.15
	Post	2.44	0.11	2.60	0.00	3.36	0.81
Control	Pre	1.98	0.18	2.08	0.16	2.22	0.83
	Mid	3.01	0.68	2.21	0.06	2.39	1.00
	Post	3.52	1.39	2.35	0.37	2.37	1.02

*Note:* Body mass reported as mean for groups in kilograms (kg). Std. D. is the standard deviation from the mean. Self-compassion (SCS-SF) was scored from 0-5 (5 being the highest score possible) and relative strength was reported as a ratio of 1RM to body mass. TNB = transgender non-binary, CW = ciswoman, CM = cisman, CP = chest press, and LP = leg press.

**Table 6:** Results from calculated means for dependent variable for chest press and leg press relative strength. Reported as a ratio of 1RM to body mass

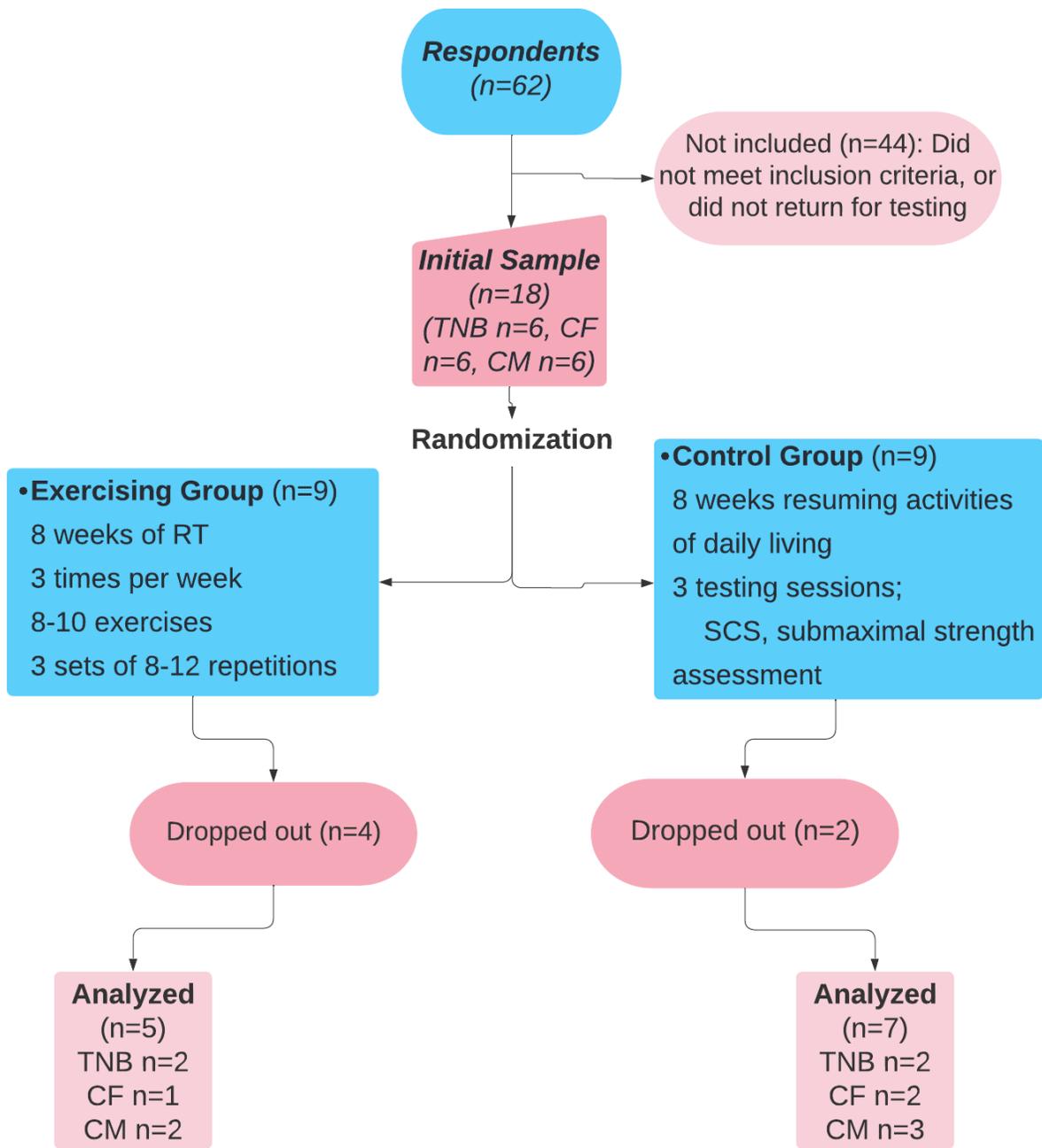
CP	Test Session	TNB	CW	CM
		Mean	Mean	Mean
RT	Pre	0.624	0.25	0.563
	Post	0.734	0.657	0.857
	% difference	0.111	0.407	0.294
	% increase	117.8027	262.68	152.1122
CTRL	Pre	0.431	0.323	0.681
	Post	0.544	0.399	0.783
	% difference	11.24	7.56	10.23
	% increase	126.0789	123.4128	115.022
LP	Test Session	TNB	CW	CM
		Mean	Mean	Mean
RT	Pre	0.209	0.211	0.190
	Post	0.244	0.260	0.336
	% difference	35	49	146
	% increase	116.7464	123.2227	176.8421
CTRL	Pre	0.198	0.208	0.222
	Post	0.352	0.235	0.237
	% difference	154	27	15
	% increase	177.7778	112.9808	106.7568

*Note.* TNB = transgender non-binary, CW = ciswoman, CM = cisman, RT = resistance training, CTRL = non-exercising control groups, CP = chest press, and LP = leg press.

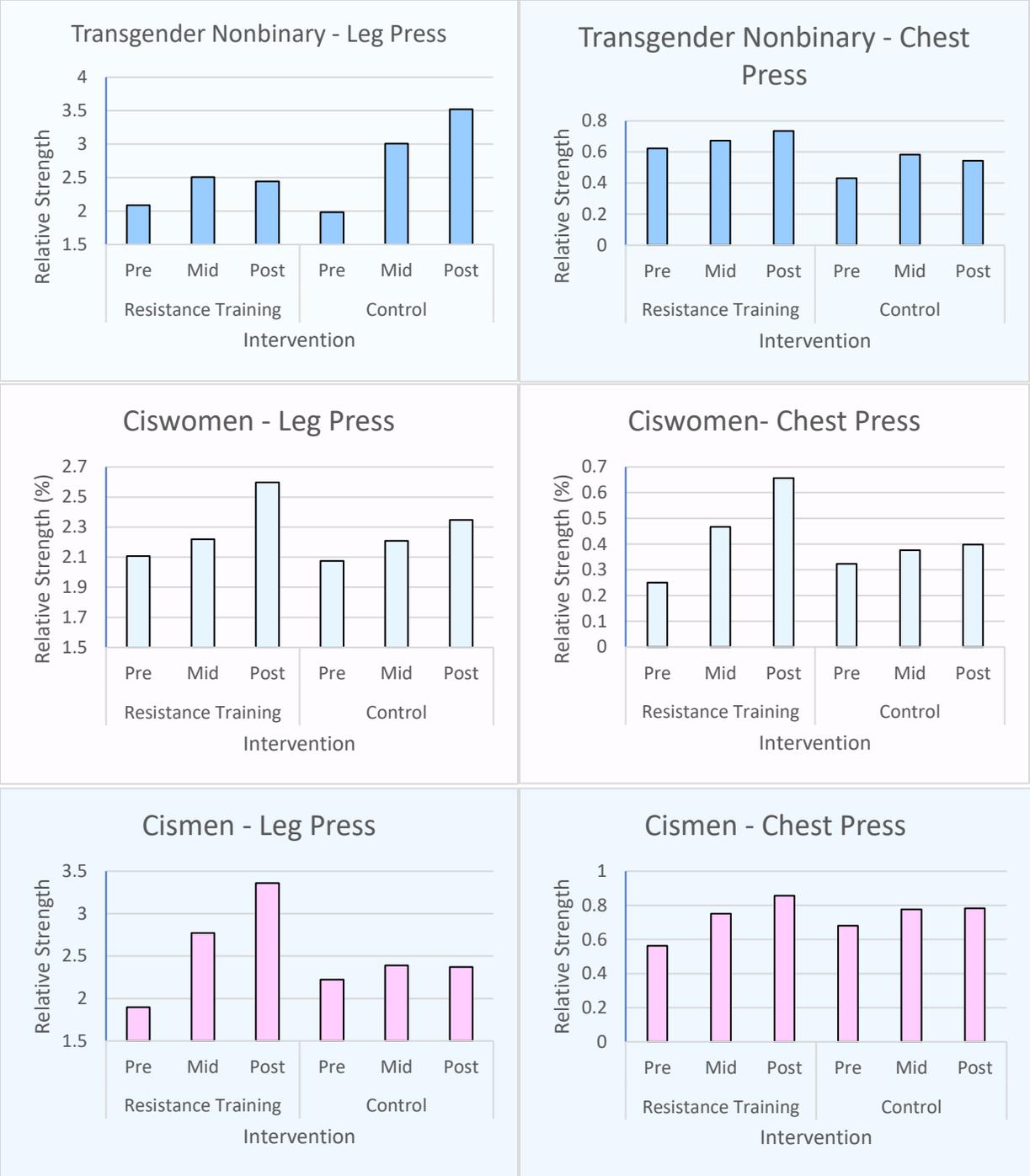
**Table 7:** Results from calculated means for dependent variable of self-compassion

SF-SCS	Test Session	TNB	CW	CM
		Mean	Mean	Mean
RT	Pre	3.13	3.25	3
	Post	3.29	3	3.42
	Change in SF-SCS	0.16	-0.25	0.42
CTRL	Pre	3.13	3.38	2.72
	Post	3.71	2.96	2.94
	Change in SF-SCS	0.58	-0.42	0.22

*Note:* Self-compassion (SCS-SF) was scored from 0-5 (5 being the highest score possible). RT = resistance training, CTRL = non-exercising control groups, TNB = transgender non-binary, CW = ciswoman, CM = cisman, CP = chest press, and LP = leg press.



**Figure 2:** Illustrates experimental design



**Figure 3:** Illustrates the differences between conditions for each variable during pre-intervention, midway (week 4), and post-intervention (week 8)

## CHAPTER II: LITERATURE REVIEW

It is well known that aerobic exercise improves aspects of health and mental wellbeing. Resistance training research and mental health presents with gaps in the literature leaving out members of the LGB and/or T community. In a study looking at the implications of COVID-19 on mental health of college students (n=43,098) 72% reported COVID-19 negatively impacted their mental health while 26% expressed concerns for their own personal health (1). Ethnic and cultural difference impact levels of anxiety and depression leaving Latinx, Black and students identifying as “other” with increased prevalence (3). Members of the LGB and/or T community shows an even greater prevalence in anxiety and depressive symptoms. When examining the prevalence of mood and anxiety in groups of differing sexual orientation, self-reporting heterosexual experienced less than half mood disorders over their lifetime when compared to LGB and/or T participants (1). These health disparities facing the LGB and/or T community could in part be explained by the Meyer MST (3,9,17).

In 2003, the Meyer minority stress model was created. Specific to LGB and/or T minority groups, this model suggests health disparities within this group that may be explained by hostile external stressors (3,9). With the threat of potential victimization, harassment, and maltreatment, LGB and/or T can be experience detriments to their personal health. This model associated coping mechanisms and stressors with positive and negative associations with mental health outcomes (17, 18).

Members of the LGB and/or T community often anticipate public spaces to be confrontational or fear facing some form of discrimination. Situations such as these increase stress responses potentially leading to protracted stress, which can then cause hypertension (3,9,17,18). Resistance training has been well documented as a means to improve symptoms of anxiety, depression, hypertension, and well as body composition (3,6,14,20). It is recommended by the ACSM to achieve 150 minutes of moderate intensity aerobic exercise per week and 2-3 non-consecutive days of RT per week (12). Researcher know, exercise can be useful for prevention of hypertension, heart disease, non-insulin-dependent diabetes mellitus as well as osteoporosis (6,7,20). Observed beneficial effects of physical activity includes: A) social interaction, B) self-efficacy, and C) distractions from daily thoughts/life (14). Distractions are thought to be the most beneficial psychological improvement through the introduction of physical activity (14).

Physical activity dose can have implications for improvement of mood and as a good distraction (2). Researchers found that resistance training at moderate intensity (55-65% of 1RM) would improve mood state but when exercising at a vigorous intensity (75-85% 1RM) for a single bout of exercise, mood state would worsen (2). These depressive moods were found to last up to 10 days or even weeks. These worsened mood states trigger a release of cortisol (2,17,19). With increasing levels of cortisol, researchers saw a correlation to anxiety. Resistance training intensity was identified to provide optimum anxiolytic effects within CW and CM individuals (2). However, researchers have not yet examined anxiolytic effects of resistance training within TNB individuals or individual. Additionally, there is potential for gender differences to appear as researchers found CW can tolerate higher intensity before their training begins to increase

anxiety. Several studies suggest resistance training at high intensity (above 80% of 1RM) is shown to increase levels of cortisol via the hypothalamic-pituitary adrenal axis (2,6,)

The HPA axis is responsible for appropriate stress responses. When in a stressful situation, the hypothalamus releases corticotrophin releasing hormone. As the corticotrophin releasing hormone binds to receptor sites on the anterior pituitary gland, it stimulates the release of adrenocorticotrophic hormone (2,15,22). Binding for adrenocorticotrophic hormone takes place in the adrenal cortex which in turn releases cortisol from the adrenals. After stressful events, cortisol levels can remain elevated for several hours (15,22). Exercise intensity can be a consideration when programming exercise for individuals within the LGB and/or T community with the expectation that they may suffer from minority stress.

Not only are there gender differences in the stress response, including one's capacity to resistance train at a higher percent of their 1RM, anatomical variations are seen as well (22,23). The differences in anatomy can impact one's ability to gain muscle mass as well as strength. Muscle thickness and fascicle length alters the potential for gains in strength. Maximum contraction velocity has been suggested to be impacted by muscle fascicle length which is seen to be greater in CM. Additionally, muscle thickness is found to be significantly greater in CM than CW (22,23). As CM tend to have greater muscle thickness, they tend to have a larger number of sarcomeres than CW (23). Increase number in sarcomeres has a positive impact on force velocity. When adjusting for muscle thickness, researchers Lyristakis et. al., determined no statistical significance between genders relative to body mass (22).

Previous research examines a comparison between CW and CM levels of relative strength. Currently, TNB have been excluded from the current body of research. Previously, it was thought that CW strength was 40 to 75% that of a CM (7). Matt Bryzcki conducted a study

comparing CW and CM powerlifting world record performance. In this trained population the strength differences were narrower, showing CW had performed the bench press at ~66 to 71% of their CM counterparts (7). When researchers began to adjust for lean body mass, they found that maximal strength in the upper body matches across genders (7).

Much of the previously mentioned research, involving resistance training and performance within the CW and CM population, leaves out TNB individuals. These individuals have additional complexities to consider with the introduction of HRT. When initiating HRT-T, the masculinizing hormone Testosterone is administered via two most common means for testosterone administration; transdermal or parentally (either IM or SC). Transdermal applications are administered via gel or patch (Androgel®, Androderm®) while parental injections of enanthate (Delastryl®) and cypionate (Depo ®-Testosterone).

Parental testosterone, suspended in a lipid, can increase lipid panels of TNB on HRT-T (24,25,26). These changes in lipid panels can be undesirable. Additionally, patients can experience increased body mass increasing risk of cardiovascular disease. When individual health is not managed appropriately, damage to kidneys can occur (25,15). Regardless of HRT status, TNB individuals must maintain regular visits to their primary care provider as it is important to continue regular cancer screenings and other screenings associated with long-term HRT (4).

Transgender nonbinary individuals on HRT-T are monitored by their physician to ensure testosterone levels are adequate for the individuals transition related goals. Initial follow-up appointments occur every three months to monitor for adverse interactions. After one year of EVT, TNB individuals will be monitored every 6-12 months (4,24,27). Individual differences in the desire to achieve varying levels of virilization is considered when providing treatment. The

dose range for testosterone allows for titration through HRT-T to reach levels of testosterone similar to that of CM (4). Typical timing of HRT-T administration occurs weekly, bi-weekly or every third week dependent on that individuals' dose and desired transition outcomes (4,24,27).

Levels of testosterone that are similar to that of CM fall between 300-1,000 ng/dL. For TNB, levels of testosterone equivalent to that of a CM can be achieved within six months of treatment (22,23,34). Circulating testosterone remains relatively constant between administration of the medication, with a serum testosterone measure peaking when administered parentally, 24-48 hours after administration. (4,24). This sets the TNB and CM apart in that the CM shows a daily or diurnal testosterone pattern that occurs naturally with endogenous cycling starting with pulsatile secretions of Gonadotropin releasing hormone (GnRH) by the hypothalamus (16,34). In contrast, TNB individuals on HRT-T will have a rise and fall in testosterone based off the frequency and dosage of the administration of testosterone therapy (4).

In those pursuing gender-affirming interventions, 60% reported moderate to severe depression. The risk of self-harm or suicidal ideation was 73% lower in those seeking gender-affirming interventions within the first year of care (5). However, members of the LGB and/or T community experienced increases in identity-related victimization during the COVID-19 pandemic. Bullying was seen to be the most frequent type of minority stress placed upon the LGB and/or T community. Researchers saw an increase in bullying by 5.5% since the start of COVID-19. Following bullying, threatening with physical harm has increased since COVID-19 in LGB and/or T individuals by 3.2% (28). The MST identifies that sexual minorities will face disparities in their lifetime will be a detriment to their health. It is believed that resistance training has the ability to improve one's mood state. In turn, levels of self-compassion may improve over time.

## CHAPTER III: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

### Conclusion

The primary purpose of this research was to assess changes in relative strength occurring during an 8-week resistance training protocol as well as changes in levels of self-compassion in TNB, CW and CM. These changes were assessed by collecting measures of submaximal strength in the leg press and chest press as well as through the utilization of a 12-question Likert scale questionnaire. The results of this study indicated there were not any significant differences between TNB, CW, and CM in both relative strength changes and levels of self-compassion. This would indicate no gender differences exist in the presence of a structured hypertrophy program.

### Limitations

The original research supported the hypothesis that structured resistance training would increase muscle mass, relative strength, levels of self-compassion. Additionally, researchers believed there may be an acute change in circulating endogenous testosterone based off of exercise selection in all groups (TNB, CW and CM) which could have implications for TNB individuals that do not have access to EVT. However, this testing required blood collection materials. Due to the increases in COVID-19 research, materials did not arrive in time for data

collection resulting in freeze-thaw cycles in the samples successfully collected. On occasion, the trained phlebotomists mentioned vacutainer seals may be compromised. With the seal on vacutainers not fully intact, vascular pressure differences to sample tubes decreased total sample amounts collected. Additionally, certain individuals were more challenging to collect samples from due to the difficulties finding the antecubital vein. After 3 collection attempts, we discontinued attempts as it wasn't ethical to collect samples.

While the research hypothesis was not accepted, the introduction of resistance training had a positive impact on relative strength across all groups. There were several limitations that are important to consider. The regional population of TNB being low resulted in a small sample size (n=18) making it difficult to draw conclusions to represent a larger population. Working with human subjects presents numerous unique challenges. Participant adherence was low. For example, a member in the CTRL condition gained significant muscle mass in the right leg only over the course of the first four weeks. Upon inquiry, participant volunteered their participation in Pep band. Dietary decisions impacted a participant in the RT condition as they volunteered not having a balanced diet and primarily eating sweets as their caloric intake.

When examining the data from tests of relative strength, recorded means for the CM CTRL group had some unusual results showing a large increase in lower body strength. With a small sample size, one individual has the ability to skew the data for the entire group. In this specific study, one of the CM individuals had recently gone through a break-up prior to the second testing session. After tests of relative strength for this individual, they apologized for changing the effort they put in during the test sessions and the variability seen.

A possible limitation was to include participants that have recently completed their first 6 months on HRT-T. With the rapid changes occurring due to the EVT, a member of the CTRL

TNB group gained 4x strength relative to their body mass from test session 1 to test session 2 only 4 weeks later. This increase in strength could be a cause of concern for tendon and ligament health and proper care must be taken.

Overall, this study did not find significant data to support the benefits of RT in conjunction with HRT-T or its impact on self-compassion. Based on participant verbal responses, initiation of new exercise was successful within 100% of exercising participants. Members of the TNB group started a strength training group to offer each other a support system and accountability. This is an incredible achievement considering the difficulties TNB individuals face. Another participant utilized the RT program to train for an upcoming long-distance cross-country ski race that they successfully finished one month after completion of data collection. Additionally, one of the participants that dropped out of the study reported re-starting the exercise program and feeling great.

## Recommendations

Due to this limitation presented, it is recommended that further research consider resistance training periodization. While this study did not see statistical significance within the analysis, it did support previous research suggesting structured resistance training will improve relative strength. Based on participant verbal response, it was inferred that the RT program provided by this project was improving their levels of confidence and seeing changes in strength. Finally, after data collection, numerous participants said the training program made them feel empowered which suggests they will continue to exercise in the future. Within the TNB community, it would be beneficial to understand their wants and needs for body related goals to determine safe training protocols to achieve individual goals.

not only for body related goals but also to determine a safe protocol for TNB individuals new to EVT to proceed through exercise without increased risk of injury.

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## APPENDICES

### Appendix A:

Notice of Northern Michigan University's Administrative Institutional Review Board Approval.



**Graduate Studies and Research**  
Marquette, MI 49855-5301  
906-227-2300  
[www.nmu.edu/graduatestudies/](http://www.nmu.edu/graduatestudies/)

#### Memorandum

**TO:** Elizabeth Wuorinen  
School of Health & Human Performance

Nadine Sikora  
School of Health & Human Performance

**DATE:** April 2, 2021

**FROM:** Lisa Schade Eckert  
Dean of Graduate Studies and Research

**SUBJECT: IRB Proposal HS21-1199**  
**IRB Approval Date 4/2/2021**  
Proposed Project Dates: **6/1/2021 – 4/1/2022**  
“Effects of Resistance Training on Exogenous Testosterone in Transgender Males”

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Your proposal “Effects of Resistance Training on Exogenous Testosterone in Transgender Males” has been approved by the NMU Institutional Review Board. Include your proposal number (HS21-1199) on all research materials and on any correspondence regarding this project.

A. If a subject suffers an injury during research, or if there is an incident of non-compliance with IRB policies and procedures, you must take immediate action to assist the subject and notify the IRB chair (dereande@nmu.edu) and NMU's IRB administrator (leckert@nmu.edu) within 48 hours. Additionally, you must complete an Unanticipated Problem or Adverse Event Form for Research Involving Human Subjects.

- B. Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant.
  
- C. If you find that modifications of investigators, methods, or procedures are necessary, you must submit a Project Modification Form for Research Involving Human Subjects before collecting data. Any changes or revisions to your approved research plan must be approved by the IRB prior to implementation.

Until further guidance, per CDC guidelines, the PI is responsible for obtaining signatures on the COVID-19 Researcher Agreement and Release and COVID-19 Research Participant Agreement and Release forms for any in person research.

All forms can be found at the NMU Grants and Research website: <http://www.nmu.edu/grantsandresearch/node/102>

## Appendix B:

### Pre-study eligibility questionnaire

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**Q1** Are you available to work out Monday, Wednesday and Friday between 4 and 6 pm (1hr minimum)?

---

**Q2** What gender do you identify with?

---

**Q3** Are you a current NMU student?

---

**Q4** Are you between the ages 18-40?

---

**Q5** What is your date of birth?

---

**Q6** Do you currently workout consistently? (specifically, 2-3 non-consecutive days of resistance training per week within the last 6 months)

---

**Q7** Do you smoke cigarettes?

---

**Q8** Do you have any current injuries? If yes/maybe, please list the injuries at the end of the survey in the box provided.

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**Q9** Are you currently on hormone replacement therapy?

---

**Q10** Have you been on hormone replacement therapy for 1 year or longer?

---

**Q11** Is your hormone replacement therapy intramuscular injections?

---

**Q12** Are your injections weekly?

---

### Appendix C:

Tests of Within-Subjects Effects						
Source		df	Mean Square	F	Sig.	Partial Eta Squared
Self-Compassion	Sphericity Assumed	2	0.04	0.284	0.758	0.045
Self-Compassion * Intervention	Sphericity Assumed	2	0.003	0.022	0.978	0.004
Self-Compassion * Category	Sphericity Assumed	4	0.177	1.255	0.34	0.295
Self-Compassion * Intervention * Category	Sphericity Assumed	4	0.113	0.799	0.548	0.21
Chest Press	Sphericity Assumed	2	0.095	33.693	<.001	0.849
Chest Press * Intervention	Sphericity Assumed	2	0.021	7.605	0.007	0.559
Chest Press * Category	Sphericity Assumed	4	0.004	1.434	0.282	0.323
Chest Press * Intervention * Category	Sphericity Assumed	4	0.007	2.44	0.104	0.449
Leg Press	Sphericity Assumed	2	1.403	6.656	0.011	0.526
Leg Press * Intervention	Sphericity Assumed	2	0.01	0.048	0.953	0.008
Leg Press * Category	Sphericity Assumed	4	0.093	0.443	0.775	0.129
Leg Press * Intervention * Category	Sphericity Assumed	4	0.427	2.027	0.154	0.403

Statistical significance accepted at  $p < 0.05$

*Note:* DF is the number of degrees of freedom. Error can be described through measures of degrees of freedom

## Appendix D:

Week Three - Three Sets - Twelve Repetitions -Two Minute Rest				
	Day One	Day Two	Day Three	Weekly Feedback
	Leg Press	Goblet Squat	Leg Press	
	Single Leg Deadlift	Leg Extension	Lunge	
	Bench Press Machine	Leg Curl	Dips	
	Seated Row	Glute Bridge	Chest Fly Machine	
	Shoulder Press	Incline Bench Press Machine	Seated Row	
	Lat Pull Down	Push Up	Chin Up/Supinated Grip Lat Pull Down	
	Biceps Curl	Bent Over Row	Arnold Press	
	Triceps Pushdown (cable)	Front Deltoid Raise (cable)	Face Pulls (cable)	
		Lateral Deltoid Raise (cable)		
	Core circuit - 2 rounds 30 seconds each		Core circuit - 2 rounds 30 seconds each	
	Dead bugs	Core circuit - 2 rounds 30 seconds each	Front Plank	
	Superman	Penguins	Left Side Plank	
	Bird Dog	Flutter kicks	Right Side Plank	
	Plank	Front Plank Pull Throughs	Superman	
		Crunches	Glute Bridge	
<b>Indicate Muscle Soreness in This Row</b>				