MISSION-DIRECT RESEARCH

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MOUNTAIN TACTICAL INSTITUTE
MTI WHITE PAPER - TECHNICAL REPORT:

The Cost of Jacket Breathability: Is Gore-Tex worth the extra cost?

The Cost of Jacket Breathability: Is Gore-Tex worth the extra cost?

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1. STUDY SUMMARY

1-1. Purpose

The purpose of this study was the assess jacket breathability and cost in order to determine if Gore-Tex is worth the extra price.

1-2. Subjects

All subjects (n=3) were actively training military or mountain athletes. Study subjects averaged a height of 70.3 +/- 2.3 in, weight of 188.7 +/- 31.7 lbs and age of 30.3 +/- 3.1 years.

1-3. Design

This study focused solely on breathability, not waterproofness, durability or windproofness. Five jackets were selected to represent five popular price-points (Coleman PVC-$15, Marmot Precip-$100, Marmot Minimalist-$200, Marmot Nano-$300 and Marmot Alpinist-$600), utilizing five prominent types of waterproof technology (PVC, fabric coating, and fabric membranes like GORE-TEX).

Each athlete completed six total trials. Trials consisted of a 30-minute brisk treadmill walk at 3.0 mph and a 15% incline, with a 50 lb ruck.

Before and after every trial researchers collected *Jacket* weights, *Base Layer* (long sleeve top) weights and *HR Monitor* weights, plus a *Total Weight* which consisted of the athlete and all their equipment. Each athlete completed an initial baseline "control" trial without a jacket. After the control was established the athletes completed five more trials, one with each of the jackets. Jacket order was randomly assigned and athletes were allowed approximately 30 minutes between trials to rest, recover and rehydrate.

Study controls were balanced against the MTI mission direct requirements. Controls were used primarily to standardize the trials across the study participants and trials. Control measures were used for the athletes, efforts, jackets, base layers, clothing, packs, hydration, temperature and humidity.

1-4. Results & Discussion

After a preliminary statistical analysis MTI researchers narrowed the focus solely to changes in *Base Layer* weight. The research assumption was that the more the athlete sweated, the heavier the base layer would become during the post-trial measurement, and thus, the less breathable the jacket.

The study produced a few significant findings. First, breathable fabrics represent a significant improvement over non-breathable fabrics. On average the 0.20mm PVC jacket (non-breathable material) increased the athlete's base layer sweat by about 6.0 oz (approximately half a can of soda or 267% over baseline). By comparison the two most breathable jackets, the Precip and the Nano, only increased the athlete's base layer sweat retention by 85% and 79%, respectively. This amounts to between 1.8 oz and 1.6 oz of sweat.

Second, *HR* (effort) and *Baseline Sweat Rate* had a significant impact on a jacket's breathability. *HR* alone could be used to predict base layer sweat to about 60% accuracy and *Baseline Sweat Rate* was accurate to about 62%. Jackets also have a significantly higher impact on lighter sweaters. On average, all five jackets produced a 400% increase in sweat in the *low sweat athlete*. In the *high sweat athlete* the overall average increase was only about 127%.

Lastly, jacket weights varied significantly. The lightest jacket, the Precip, weighed approximately 11.5 ounces. The heaviest jacket, the Alpinist ,weighed almost eight ounces more, 19.4 ounces. A quick comparison of jacket weight to breathability revealed the study's only significant correlation - As jacket weight increased breathability decreased.

1-5. Conclusion and Recommendations

Conclusions:

1. **Breathable fabrics work.**
   Simply put, breathable jackets can help decrease sweat by as much as 500% when compared to non-breathable jackets.

2. **The more someone sweats the less effect "breathability" has on base layer sweat.**
   This can be seen in a few places in the study's data. First, our heavier sweaters were less effected by the jackets. Second the harder an athlete worked the less effective the breathability was at removing base layer sweat. And lastly, anecdotally, the heavier the jacket, the more the athlete sweated and the more sweat was retained in the base layer.

3. **Jacket pricing is not related to breathability.**
   Jacket pricing is a product of, among other things, durability, fit, features, fabric, waterproofness, windproofness and, finally, breathability. Our study showed almost no relationship between price and breathability. In fact, based on this study, less than 9% of the jacket's cost can be accounted for by its breathability.

Recommendations

If an athlete's only concern is finding a cost-effective, waterproof, breathable jacket then, based on this study's findings, Gore-Tex does not appear to be worth the price. This study showed that breathable coatings (like the NanoPro) offer superior breathability at a much lower cost.

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3. INTRODUCTION

3-1. Previous Research

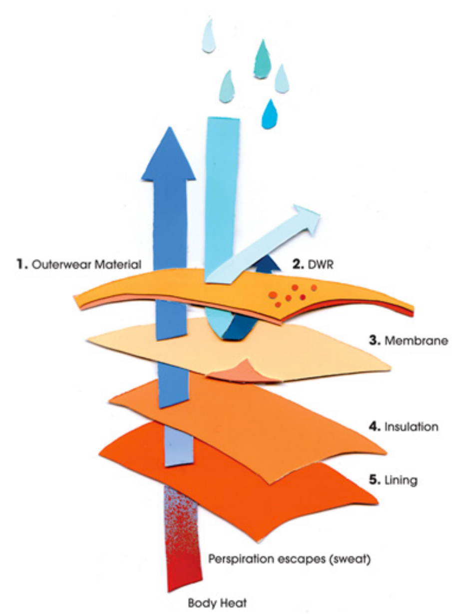
3-1.1 *Breathability*

A garment's *breathability* is determined by the ability of the fabric to transfer moisture through its layers, away from the wearer and into the environment.

Breathable fabrics utilize two means to transfer water vapor away from the wearer: physical (hydrophobic systems) and chemical (hydrophilic systems).[1]

Physical systems, the most common, utilize the "differential pressure" between the inside and outside of the garment to expel water vapor. Basically, the porous nature of the fabric allows water vapor to escape the warmer, more humid internal environment, creating equilibrium with the outside air.[2] The FIGURE below is a basic example of how the process works.

FIGURE: Example of Physical System (from www.evo.com)[3]



3-1.2 Previous Tests

There are a number of tests designed to assess fabric breathability.[4] MTI found at least eight different protocols, but there are probably many more.

Unfortunately, almost every test MTI found failed to assess the materials under the real-world conditions in which they are used. Instead, these tests took place in highly controlled laboratory environments. And while

[1] (1) Mukhopadhyay, A and Midha, V. A Review on Designing the Waterproof Breathable Fabrics Part I: Fundamental Principles and Designing Aspects of Breathable Fabrics. J of Ind Textiles; 27(4): 225-262. 2008

[2] (7) Waterproof ratings and breathability guide. Evo. 3500 Stone Way, Seattle, WA,98103. http://www.evo.com/waterproof-ratings-and-breathability-guide.aspx. Accessed: 28 FEB, 2016.

[3] (7) Waterproof ratings and breathability guide. Evo. 3500 Stone Way, Seattle, WA,98103. http://www.evo.com/waterproof-ratings-and-breathability-guide.aspx. Accessed: 28 FEB, 2016.

[4] (8) Test Methods Measuring Breathability. Nemo Equipment. 383 Central Ave, Suite 400, Dover, NH 03820. www.nemoequipment.com Accessed: 28 FEB, 2016.

this is great for an academically "clean" study, it begs the question as to whether or not these test have a real-world application.

Three of the five most common tests we found took place in wind tunnels, housed in an environmental chamber (not exactly the great outdoors). These three tests used cups of water (or a water solution) and a collection chamber. The cup and collection were separated by the fabric being tested. These tests measure the water vapor which is transferred through the fabric to determine what is called: "water vapor transmission rate" (WVTR). Test like these are what produce the "A1", "B1" and "B2" ratings (measured in gr/m2/day).

Another common test, called the "RET" or Hohenstein Test, measures the power it takes to keep plates heated when water vapor is evaporated and diffused through the fabric being tested.[5] Hohenstein did try to add a real-world aspect to the test by having individuals wear the garments and rate their comfort, but this was mainly done to correlate RET scores to the comments. RET scores range from 0 (extremely breathable) to 30+ (not breathable).

Lastly, MTI also found a 2000 study conducted at the U.S. Army Soldier System Center which used water vapor diffusion and a diode laser spectroscope to test commercial outerwear layers.[6,7,8] Although it was under extremely controlled measures the study did support the superior performance of the high-end jacket materials. This particular study found that Expanded Polytetrafluoroethylene (ePTFE) membranes like those in GORE-TEX were by far the most breathable material at nearly every relative humidity.[9]

3-2. MTI's Mission Direct Approach

MTI's examination of previous research on breathability revealed at least 24 different variables which affected a jacket's breathability.[10] All of these studies have utilized highly controlled laboratory settings to control the variables. However, our commitment to mission-direct solutions requires us to get outside the lab and add as much practicality as possible to the experiment. Taking the jackets out of the lab and putting them on our athletes means we not only add additional variables, but we also accept a great deal more risk in controlling them. MTI completely understands these risks, and excepts them.

Teasing out each jacket's breathability means the experimental design must account for as many of the independent factors as possible, but without compromising the real-world applicability. For this MTI utilized crowdsourced recommendations from its network of military and mountain professionals and multiple-repeated pilot studies in order to determine, amongst other things: *What assumptions can we make? What measures must we address? Is something being over looked? Etc?*

The goal of Mission Direct research isn't publication. The goal is to quickly identify actionable solutions to improve mountain and tactical athletes' mission performance. In the end, *Mission Direct* means instantaneously improving performance by putting actionable solutions directly into the hands of those at the tip of the spear.

[5] (8) Test Methods Measuring Breathability. Nemo Equipment. 383 Central Ave, Suite 400, Dover, NH 03820. www.nemoequipment.com Accessed: 28 FEB, 2016.

[6] (4) Gibson, P.W. Effect of Temperature on Water Vapor Transport Through Polymer Membrane Laminates. J of Polymer Testing; 19(6). 2000.

[7] (5) Gibson, P; Rivin, D and Kendrick, C. Convection/Diffusion Test Method for Porous Textiles. Int J Clothing Science and Tech; 12(2). 2000.

[8] (6) Gibson, P. Water Vapor Transport and Gas Flow Properties of Textiles, Polymer Membranes, and Fabric Laminates. J of Coated Fabrics. 1999.

[9] (4) Gibson, P.W. Effect of Temperature on Water Vapor Transport Through Polymer Membrane Laminates. J of Polymer Testing; 19(6). 2000.

[10] (3) Huag, J. Review of heat and water vapor transfer through multilayer fabrics. Textile Res J; 86(3), 325-226. 2016.

4. STUDY DESIGN

4-1. Subjects

All subjects (n=3) were actively training military or mountain athletes. Subject's descriptive characteristics are provided in the table below.

TABLE: Subject's Descriptive Data

	Athlete 1	Athlete 2	Athlete 3	AVG	SD
Height	69 in	73 in	69 in	70.3	2.3
Weight	174 lb	225 lb	167 lbs	188.7	31.7
Age	33 yrs	27 yrs	31 yrs	30.3	3.1

4-2. Materials and Methods

This study focused solely on breathability, not waterproofness, durability or windproofness. All five of the jackets tested were certified as "waterproof" (10,000mm - Minimum JIS-L 1092) and at least four were certified as windproof (CFM <1.0).

The jackets were selected to represent five popular price-points (Coleman PVC-$15, Marmot Precip-$100, Marmot Minimalist-$200, Marmot Nano-$300 and Marmot Alpinist-$600), utilizing five prominent types of waterproof technology (PVC, fabric coating, and fabric membranes like GORE-TEX). The table below shows the basic, available information concerning the five tested jackets.

TABLE: Jacket Information

	JACKETS	**Coleman**	**Precip**	**Minimalsit**	**Nano AS**	**Alpinist**
	Fabric	.20mm PVC	Nylon 2.2oz / yd	Polyester 3.6oz / yd	Nylon 3.3oz / yd	Nylon 3L 3.9oz / yd
	Weight	18.9oz	11.5oz	15.7oz	11.7oz	19.4oz
	Price	$15.00	$100.00	$200.00	$290.00	$600.00
	Technology	*N/A*	*NanoPro*	*GORE-TEX Paclite*	*GORE-TEX Active*	*GORE-TEX Pro*
	Tech Type	-	Coating	2.5 Layer ePTFE	3-Layer ePTFE	3-Layer ePTFE
Waterproof	JIS-L1092	-	10,000 mm	28,000 mm	23,000 mm	28,000 mm
Windproof	CFM	-	0.2 CFM	-	-	-
Breathability	RET	-	5.0-5.4	4.0-4.5	3.0-4.0	3.0-6.0
Breathability	A1	-	11,500 gm	-	-	-
Breathability	B1	-	17,000 gm	-	-	-
Breathability	B2	-	-	15,000+ mm	-	25,000+ mm

4-3. Location

Testing took place in the MTI gym, on a treadmill in Jackson, WY. This approach allowed for control over important metrics such as terrain, pace, temperature and humidity. Utilizing the the gym allowed the researchers to accurately measure and assess the environmental factors which influenced the test while still allowing the athlete's the opportunity to perform in the jackets.

4-4. Methods

4-4.1 Trials

Each trial consisted of a 30-minute brisk walk on a treadmill. Athletes wore a HR monitor, identical long-sleeve base layer top and ruck weighing approximate 50 lbs. Athletes walked at a 15% incline at a speed of approximate 3.0 mph.

4-4.2 Order and Timing

Before and after every trial researchers collected *Jacket* weights, *Base Layer* (long sleeve top) weights and *HR Monitor* weights, plus a *Total Weight* which consisted of the athlete and all their equipment. Each athlete completed an initial baseline "control" trial without a jacket. After the control was established the athletes completed five more trials, one with each of the jackets. Jacket order was randomly assigned and athletes were allowed approximately 30 minutes between trials to rest, recover and rehydrate.

4-5. Study Controls

Study controls were balanced against the mission direct requirements. The following controls were used primarily to standardize the trials across the study participants and trials. All of the recorded differences represent statistically insignificant variations across trials. A statistical analysis of the differences showed that none of the below controls effected the trails adversely. Page 8 contains a TABLE which shows all of the controls utilized in the study.

TABLE: Research Control Measures

	Measurement(s)	Control(s)	Control Measurement(s)
(1) Athletes	*Height, Weight, Age*	- Descriptive measures were taken prior to the experiment and identical, non-jacket "baseline" trials were completed prior to jacket trials.	**Height** = 70.3 +/- 2.3 in **Weight** = 188.7 +/-31.7 lbs **Age** = 30.3 +/- 1.3 yrs
(2) Effort	*HR, Speed* and *Distance* over 30 min	- All trials were 30 mins in duration. - Athletes walked at a 15% incline and approximately 3.0 mph.	**HR** = 168.7 +/- 13.7 **Speed** = 3.0 +/- 0.2 mph **Incline** = 15% +/- 0.0%
(3) Jackets	*Jackets weighed* pre- and post-trials	- All jackets were size (L) and four of five jackets came from the same manufacturer - minimizing differences in fit. - All jackets were weighted prior to their trials to ensure jackets were free of residual sweat. - Jackets were wore fully zipped, cinched and with hoods up.	Pre-Trail weights: - **Col** = 18.9 +/- 0.07 oz - **Pre** = 11.5 +/-0.18 oz - **Min** = 15.7 +/- 0.0 oz - **Nan** = 11.7 +/- 0.14 oz - **Pro** = 19.4 +/- 0.07 oz
(4) Base Layers	*Base layers* were weighed pre- and post-trials	- All trials utilized new, identical long-sleeve base layers. - Base layers were the same size (L), color, manufacturer (A4) and material (100% polyester).	**Base Layer** = 6.7 +/- 0.06 oz
(5) Clothing	*Athlete total weight* was collected prior to the study	- Athletes wore self-selected tennis shoes, socks, shorts and under garments.	**Total Weight** = 238.1 +/- 33.2 lbs
(7) Packs	*Athlete total weight* was collected prior to the study	- All packs were the exact same make: external frame, Alice packs. - All packs were loaded with identical weights: 4x 10lb metal plates (total weight = approximate 50 lbs).	**Total Weight** = 238.1 +/- 33.2 lbs
(8) Hydration	*Urine specific gravity* - prior to each 30 minute trial.	- Athlete's consumed a minimum of 500ml of water during each 30 min trial.** - Athlete consumed 500-750ml of water during their 30 min rest period.**	**Urine Specific Gravity** = 1.007 +/- 0.08*
(9) Temperature	*Ambient temperature* -every 5 mins	- N/A	**Temp** = 59.6 +/- 1.4 degrees Fahrenheit
(10) Humidity	*Ambient humidity* - every 5 mins	- N/A	**Humidity** = 45.5 +/- 4.2 %

* Normal range for healthy, hydrated adults is 1.005-1.030.[11]
** Hydration protocol was derived from ACSM Guidelines.[12]

[11] (9) Daniels R. *Delmar's Guide to Laboratory and Diagnostic Tests*. 2nd ed. Ashland, Oregon: Oregon Health and Science University 2010.

[12] (10) Simpson, M and Howard, T. ACSM Information On…Selecting and effectively using hydration in fitness. The American College of Sports Medicine. ACMS's consumer information committee. Accessed from: https://www.acsm.org/docs/brochures/selecting-and-effectively-using-hydration-for-fitness.pdf. 2011.

4-6. Data Collection

The goal of this study was to determine which fabric offers the most breathability. To determine breathability, comparative statistics were be gathered before and after each activity. These statistics were used to determine the amount of water weight lost to evaporation through the test jacket. Data collection for each activity was: urine specific gravity, athlete plus equipment weight, ambient temperature, ambient humidity, jacket weight and base layer weight.

4-7. Data Analysis

Fabric breathability was assessed in terms of weight lost during a jacket's respective trial. To do this, MTI weighed the athlete's jacket, base layer (long sleeve top) and HR monitor, plus collected a "Total Weight" (athlete with equipment), immediately before conducting the trials. After the 30 minute trial, MTI re-collected all four measures. To calculate breathability, post-trial weights were subtracted from pre-trial weights.

Descriptive statistics were conducted using Microsoft Excel version 15.20 (2016). Advanced statistics were conducted using IBM Watson Analytics, IBM Corp (2014) and The University of Colorado - Colorado Springs Statistics Calculator by Dr. Lee A. Becker (1999).

5. RESULTS & DISCUSSION

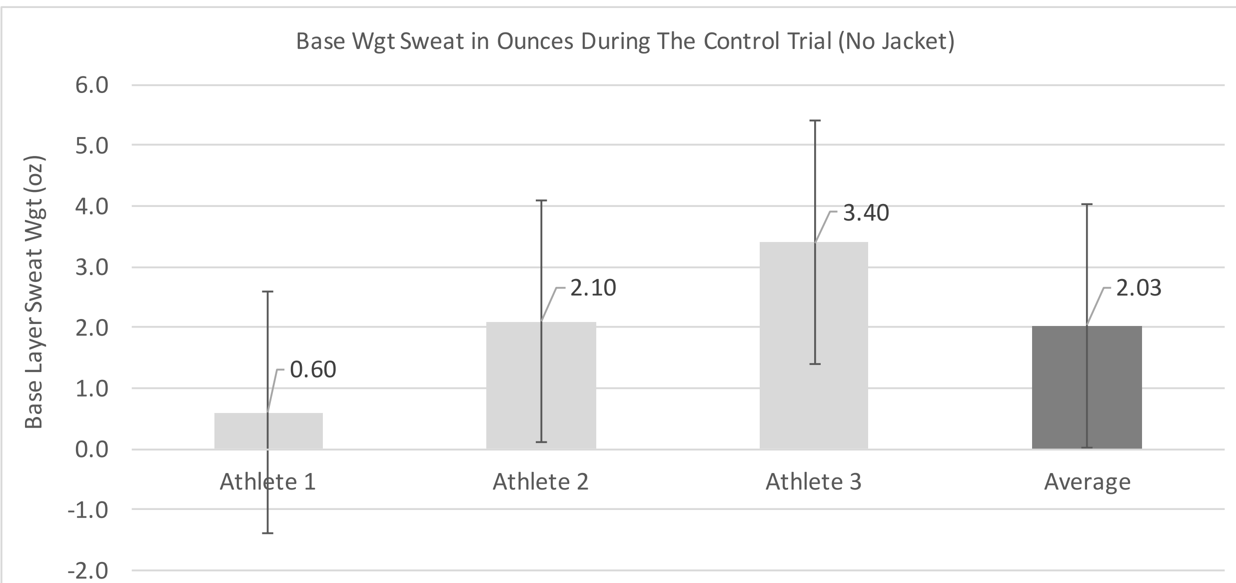
MTI collected four weights in order to assess jacket breathability. Initial statistical tests revealed that no valuable data was contained in the of the three of the measures. First, *Total Weight* (athlete and equipment) was removed because the researchers determined that the equipment was not sensitive enough to track the small changes in water loss. Next, *HR Monitor Weight* (chest strap) was also removed from the data collection because it was found to be identical across each trial and, overall, insignificant (<0.1% of total water loss). Lastly, *Jacket Weight* was removed from the data analysis because, while interesting, the researchers decided that weight changes in the jacket did not necessarily have a meaningful impact on the study's mission direct definition of "breathability."

Removing these three measurements narrowed the researchers' focus solely to changes in *Base Layer* weight. Thus, the research assumption was that the more the athlete sweated, the heavier the base layer would become during the post-trial measurement, and thus, the less breathable the jacket.

5-1. Baseline Results

The graph below contains the base layer sweat weight for each of the three athletes during their non-jacketed, control trial.

GRAPH: Sweat in Ounces During Control Trial (No Jackets)

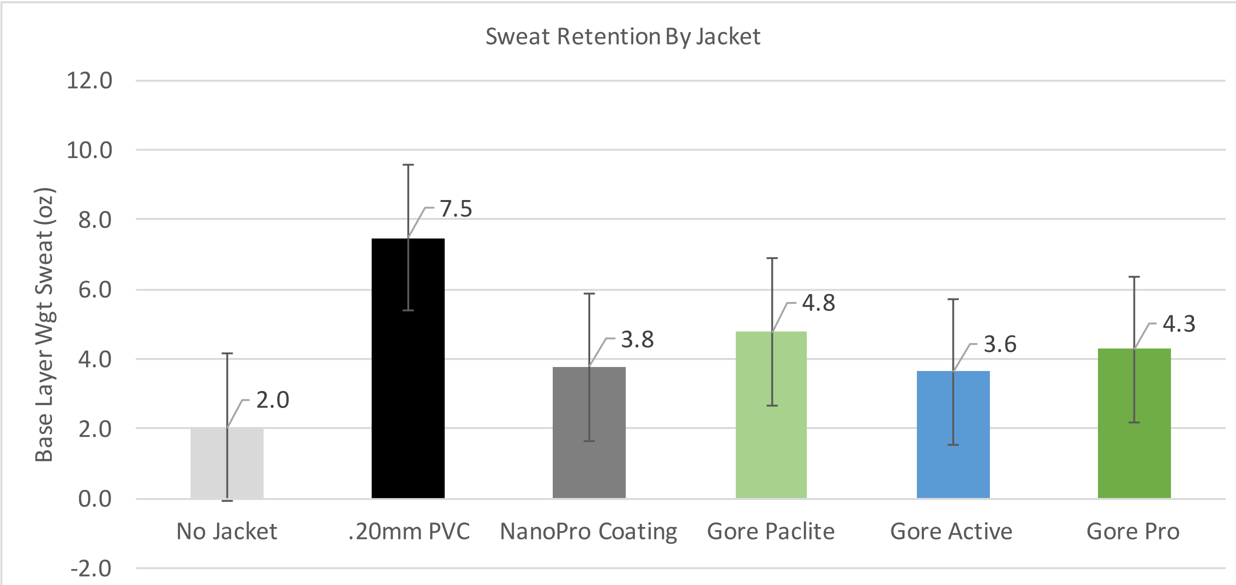


Athlete's baseline sweat varied significantly during baseline trials (0.6 oz to 3.4 oz). However, the variation was actually somewhat serendipitous, since, contained in the small sample, the study was able to assess a low sweater (Athlete 1), a moderate sweater (Athlete 2) and a heavy sweater (Athlete 3). Overall, the average sweat collected during the baseline was 2.03 oz.

5-2. Overall Sweat Retention

To establish the breathability of each jacket the researchers averaged the results for all three athletes and compared them to the average baseline (non-jacket) sweat retention. The graph below shows how each jacket performed in comparison to the baseline.

GRAPH: Base Layer Sweat Retention With and Without Jackets



Without a jacket our athlete's averaged approximately 2.0 oz of sweat in their base layer (far left bar graph). The graph above shows the significant impact a non-breathable jacket can have on sweat. When wearing the PVC jacket sweat retention increased by an average of nearly 6.0 oz, or half a can of soda. In the heavy sweating athlete the increases was almost a full can (10.2 oz). On average the 0.20mm PVC jacket increased the athlete's base layer sweat by approximately 267%.

By comparison the two most breathable jackets, the Precip and the Nano, only increased the athlete's base layer sweat retention by 85% and 79%, respectively. This amounts to between 1.8 oz and 1.6 oz of sweat.

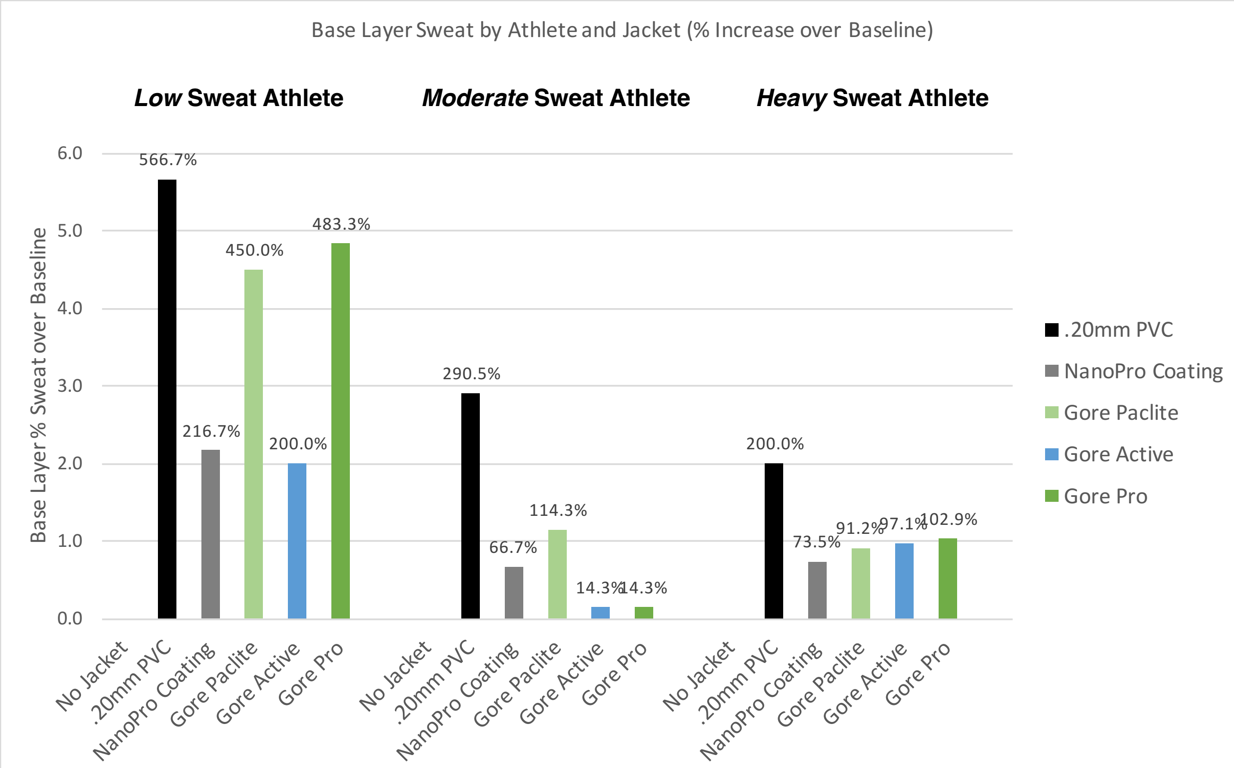
5-3. Sweat Rate Effect on Jacket Performance

Multiple variables effect sweat rate. The study design controlled for most of them, like: T*emperature, Humidity* and *Hydration*. However, a few others escaped the control measures. Two of them were found to have a significant impact on jacket performance. They were *HR* (effort) and *Baseline Sweat Rate*.

An analysis of variation (ANOVA) showed that both of the measures alone had a statistically significant impact on the base layer sweat rate, and therefore, by the researcher's definition, jacket breathability. *HR* alone could be used to predict base layer sweat to about 60% accuracy, $F(2,14) = 8.96$, $p < .01$. *Baseline Sweat Rate* could be used to predict base layer sweat to about 62% accuracy, $F(4,14) = 4.09$, $p = .03$.

Lastly, by dividing the three athletes into *low, moderate* and *heavy* sweaters the researchers were able to compare jacket performance using a high-low analysis. The graph below shows how each athlete response to the jackets. The graph clearly shows the significant impact jackets have on lighter sweaters. On average, this equated to about a 400% increase in sweat in the *low sweat athlete*. In the *high sweat athlete* the overall average increase was only about 127%.

GRAPH: Base Layer Sweat Percent Increase by Athlete



5-4. Jacket Weight and Sweat Rate

Jacket weights varied significantly. The lightest jacket, the Precip, weighed approximately 11.5 ounces. The heaviest jacket, the Alpinist ,weighed almost eight ounces more, 19.4 ounces. A quick comparison of jacket weight to base layer sweat rate (i.e. breathability) revealed the study's only significant correlation. Jacket weight and breathability were found to have a statistically significant correlation of 0.52 (using Pearson's r), $p < .05$.

6. CONCLUSIONS & RECOMMENDATIONS

6-1. Conclusions

2. **Breathable fabrics work.**
   By simply comparing the effects of the PVC fabric (no breathability) to the four breathable jackets the data clearly shows the positive effect of breathable fabrics. The PVC jacket accounted for an average of 5.5 oz of additional base layer sweat. The next closest jacket, the Gore-Tex Paclite jacket accounted for less than half that amount (2.8 oz). This was followed by the NanoPro coated jacket and finally the Gore-Tex Active Jacket (2.3 oz, 1.8 oz and 1.6 oz, respectively). Simply put, breathable jackets can held decrease sweat by as much as 500%.

3. **The more someone sweats the less effect "breathability" has on sweat removal.**
   This can be seen in a few places in the study's data. First, the heavier the sweater, the less effect the jacket had. Another factor which decreased a jacket's breathability was the athlete's effort (HR). As HR increased the jacket's breathability decreased. And lastly, anecdotally, the heavier the jacket, the more the athlete sweated and the more sweat was retained in the base layer. Although we cannot determine the exact mechanism (fabric thickness or increased sweat rate) our study showed that heavier jackets were less breathable.

4. **Jacket pricing is not related to breathability.**
   Jacket pricing is a product of, among other things: durability, fit, features, fabric, waterproofness, windproofness and, finally, breathability. Our study showed almost no relationship between price and breathability. A simple linear regression of jacket pricing and jacket breathability produced an almost nonexistent coefficient of determination (r-squared) of .09. This means that less than 9% of the jacket's cost can be accounted for by its breathability.

6-2. Recommendations

If an athlete's only concern is finding a cost-effective, waterproof, breathable jacket then, based on this study's findings, Gore-Tex does not appear to be worth the price. This study showed that breathable coatings (like the NanoPro) offer superior breathability at a much lower cost.

7. MTI MISSION DIRECT LIMITATIONS & NEXT STEPS

7-1. Limitations

Keeping in-line with our commitment to mission direct solutions this study was conducting under real-world conditions. Unfortunately this commitment created a few limitations in the study design. Some of these limitations include:

- **Equipment:** One of the major limitations of the study was the equipment. Highly accurate weight measurements were needed to assess slight changes in water weight (often tenths of ounces). While this was possible on a smaller scale like shirts and jackets (<20 pounds), at higher weights, like those of the athlete and pack, the study was unable to accurately assess changes.

- **Short study time:** Our study was completed in just two days. A longer study would have allowed for multiple trials with each jacket, and thus, increased statistical significance.

- **Small, narrow sample size:** The study was completed with a sample size of only three athletes; all of which were relatively similar (trained, males, 20-30 years old, etc.). Obviously smaller sample sizes mean that finding statistical significance is slightly more difficult. The narrowness of the sample also makes it difficult to generalize the findings to a broader audience.

- **Lack of variety:** The study was designed to test the cost effectiveness of Gore-Tex. To do this, three types of Gore-Tex were selected. However, only one other variety of breathable fabric was used as a comparison. Additionally, jacket's can come in a variety of fabrics and weights, all of which greatly effect breathability and cost. This current study only assessed two three types of fabric.

- **Environment:** The environmental conditions used in the test were extremely narrow. While this was good for study controls, it does not represent the true variety of conditions in which the jackets could be used. This makes it difficult to make broad generalizations on how the jackets would perform under other conditions.

7-2. Next Steps

Moving forward, MTI would like to broaden the study to examine a few additional factors. First, MTI would like to examine more types of breathable fabrics (like eVent and NeoShell). It is very possible that other coatings and membranes could offer superior performance and additional insights. Another possible way to broaden the study would be to examine the other factors which make up a jacket's performance and price, like: durability, fabric, waterproofness and windproofness. While certain measurements for these features already exist, MTI is interested in applying mission direct tests to them. Lastly, being able to move outside the lab and test would be

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