



## Cold Weather, Attendance, and Equity

### Key Findings

1. Extreme cold affects student attendance overall, with a particularly high impact for African-American students, students receiving free/reduced lunch, and Hispanic students.
2. Two case studies of extremely cold days when MMSD schools remained open highlight extreme examples of this varied effect, with African-American student attendance dropping 30 or more percentage points but attendance rates for white students dropping fewer than 10 percentage points relative to the previous days.
3. Students who typically walk to school were less affected by the cold than those who typically ride the bus or get to school another way, with the exception of students walking 1.5 miles or more.
4. Attendance rates were around 75% on these extremely cold days and higher for certain student groups, suggesting that remaining open allowed MMSD to serve a significant majority of its students.

In the Madison Metropolitan School District, school closure decisions are made by the Superintendent with the support of a committee including other senior leaders. In this report, we examine the effect of cold weather on student attendance with a focus on varied effects by student group.

### Methods

First, we examined case studies of two particularly cold days where MMSD made the decision to stay open while surrounding districts closed, selected intentionally because of the combination of extreme cold and surrounding district closures. We focused on student attendance rates for these days and prior school days to examine how attendance changed across student subgroups. We paid particular attention to racial/ethnic and income-related gaps in attendance. All included attendance rates are approximate and based on daily absences and student counts.

Then, we created a dataset containing daily low temperatures for every school day between September 1, 2013, and January 8, 2015 (approximately one and a half school years). We then calculated daily attendance rates for each of these days overall, across racial/ethnic groups, and by free/reduced lunch status. To estimate the effect of cold weather on student attendance, we conducted regression analysis to estimate the effect of temperatures below 0°F and below freezing. To isolate the effect of temperature, we also controlled for day of week and snowfall each day. We also restricted the date range to include November 1 through March 31 only to avoid having extreme heat influence our findings.

### Case Studies

#### Wednesday, January 7, 2015

On Wednesday, January 7, 2015, MMSD schools remained open despite unusual cold. Temperatures during the school day dropped to -5° Fahrenheit and wind chills dropped to -26° Fahrenheit. The table below shows temperature data from that day and the two subsequent days:

Day	8:00 temperature	3:00 temperature	School day low wind chill
1/7/2015	-5°F (-25°F wind chill)	-1°F (-18°F wind chill)	-26°F (9:00)
1/8/2015	-4°F (-24°F wind chill)	5°F (-10°F wind chill)	-25°F (10:00)
1/9/2015	0°F (-12°F wind chill)	5°F (-11°F wind chill)	-18°F (10:00)

The table below shows estimated attendance rates around January 7, 2015 by student group.

Date	Overall	Asian	African-American	Hispanic	Multiracial	White	Not free/reduced	Free/reduced
12/17/2014	91.5%	93.6%	88.4%	91.4%	89.4%	92.8%	93.4%	89.5%
12/18/2014	91.7%	93.5%	88.5%	91.3%	90.6%	93.1%	93.4%	89.8%
12/19/2014	90.4%	91.8%	87.5%	90.1%	89.4%	91.6%	92.0%	88.6%
1/5/2015	90.1%	93.4%	82.6%	88.4%	89.0%	93.5%	94.1%	85.8%
1/6/2015	91.9%	94.3%	86.6%	91.1%	91.5%	94.1%	94.6%	89.0%
<b>1/7/2015</b>	<b>72.8%</b>	<b>82.7%</b>	<b>50.8%</b>	<b>62.2%</b>	<b>67.7%</b>	<b>85.8%</b>	<b>87.5%</b>	<b>57.1%</b>
1/8/2015	87.0%	91.3%	76.9%	85.7%	83.2%	91.7%	93.0%	80.6%
1/9/2015	90.4%	92.7%	83.4%	89.7%	88.8%	93.5%	94.4%	86.2%



Attendance overall on January 7 dropped nearly 20% over the previous day, but the decreases were even more pronounced for certain student groups. African-American attendance dropped from a typical rate between 85%-90% to 50.8%, 35 percentage points lower than the rate for white students (who only dropped about 8 percentage points). Similarly, attendance for students receiving free/reduced lunch dropped from a typical rate around 89% to 57.1%, 30 percentage points lower than the rate for students not receiving free/reduced lunch. Attendance rebounded significantly on January 8 but remained below typical rates, particularly for students of color and students receiving free/reduced lunch. By January 9, attendance returned to almost typical rates.

We suspected that attendance would vary not just by student group, but by the transportation method the student typically uses to get to school. MMSD data systems indicate whether students take the bus or walk to school. The table below shows how attendance rates varied by transportation method and level. "Other" indicates students not listed as either bus riders or walkers and incorporates all other methods of getting to school. Walkers are disaggregated by the distance between their mailing address and their school as the crow flies. Students in middle and high school take city buses (with a few exceptions in areas with no Metro bus service); as such, we do not have a record of their city bus riding and cannot disaggregate bus riders at those levels, many of whom likely fall into the "Other" category.

Date	Elementary					Middle					High					
	Bus	Walk <.5 miles	Walk .5-.99 miles	Walk 1-1.49 miles	Walk 1.5+ miles	Other	Walk <.5 miles	Walk .5-.99 miles	Walk 1-1.49 miles	Walk 1.5+ miles	Other	Walk <.5 miles	Walk .5-.99 miles	Walk 1-1.49 miles	Walk 1.5+ miles	Other
12/15/2014	90.8%	89.7%	89.4%	91.0%	85.0%	92.3%	92.8%	92.6%	92.3%	85.0%	90.8%	91.3%	91.1%	90.1%	89.2%	86.7%
12/16/2014	92.1%	91.0%	90.5%	84.2%	89.0%	92.1%	90.9%	93.5%	91.4%	91.6%	91.1%	90.8%	90.3%	87.7%	86.3%	88.1%
12/17/2014	93.2%	91.6%	92.0%	97.3%	88.0%	93.4%	91.7%	93.4%	91.0%	91.6%	91.4%	91.7%	90.7%	90.6%	83.6%	88.2%
12/18/2014	93.3%	92.3%	92.1%	96.0%	91.9%	93.4%	92.4%	91.6%	88.6%	86.5%	91.5%	91.7%	90.4%	90.3%	83.9%	88.7%
12/19/2014	92.4%	90.8%	90.2%	98.6%	84.6%	93.0%	90.7%	91.5%	89.9%	87.4%	91.0%	89.3%	87.7%	88.7%	79.3%	86.3%
1/5/2015	90.9%	89.2%	89.8%	82.9%	85.0%	90.8%	90.9%	91.3%	92.1%	84.7%	90.2%	91.6%	90.6%	89.1%	90.8%	88.0%
1/6/2015	93.5%	92.6%	92.7%	86.0%	84.6%	91.8%	92.4%	92.2%	93.6%	87.0%	92.1%	93.4%	90.8%	88.5%	86.6%	89.1%
<b>1/7/2015</b>	<b>71.7%</b>	<b>73.6%</b>	<b>76.8%</b>	<b>75.5%</b>	<b>67.1%</b>	<b>71.1%</b>	<b>74.6%</b>	<b>76.1%</b>	<b>71.5%</b>	<b>47.8%</b>	<b>68.0%</b>	<b>82.8%</b>	<b>80.3%</b>	<b>80.1%</b>	<b>71.9%</b>	<b>67.9%</b>
1/8/2015	88.2%	88.1%	88.8%	87.7%	81.9%	86.5%	87.4%	88.4%	87.5%	81.0%	85.2%	89.3%	89.8%	87.3%	81.4%	83.8%
1/9/2015	91.8%	90.0%	91.8%	89.6%	84.1%	90.7%	92.4%	91.4%	92.4%	88.2%	90.5%	91.8%	90.7%	90.6%	86.4%	87.7%

Across levels, it appears that students walking to school had the highest attendance rates, although students walking more than 1.5 miles had noticeably lower attendance (which is true for most school days).

**Monday, January 27, 2014**

On Monday, January 27, 2014, MMSD schools remained open despite cold temperatures. Temperatures during the school day dropped to -8° Fahrenheit and wind chills dropped to -31° Fahrenheit.

Day	8:00 temperature	3:00 temperature	School day low wind chill
1/27/2014	-8°F (-23°F wind chill)	-4°F (-24°F wind chill)	-31°F (10:00)

The table below shows estimated attendance rates around January 27, 2014 by student group.

Date	Overall	Asian	African-American	Hispanic	Multiracial	White	Not free/reduced	Free/reduced
1/17/2014	92.7%	95.2%	88.9%	92.4%	91.7%	94.1%	94.7%	90.6%
1/21/2014	92.7%	93.9%	89.6%	92.3%	91.5%	94.2%	94.9%	90.4%
1/22/2014	94.4%	96.0%	92.1%	94.2%	93.2%	95.4%	95.9%	92.8%
1/23/2014	93.7%	94.8%	90.2%	93.5%	92.2%	95.3%	96.0%	91.3%
1/24/2014	90.1%	93.6%	84.2%	86.5%	87.0%	93.9%	94.9%	84.9%
<b>1/27/2014</b>	<b>75.2%</b>	<b>84.5%</b>	<b>55.4%</b>	<b>70.0%</b>	<b>70.3%</b>	<b>84.7%</b>	<b>87.0%</b>	<b>62.6%</b>
1/29/2014	93.5%	95.6%	89.9%	93.5%	91.7%	95.0%	95.4%	91.5%
1/30/2014	93.7%	95.3%	91.0%	93.6%	91.3%	95.0%	95.3%	91.9%

The same themes observed around January 7, 2015, also can be observed around January 27, 2014. Attendance dropped significantly, especially for African-American students and students receiving free/reduced lunch. Schools were closed on January 28, so the one-day attendance rebound cannot be observed; attendance returned to normal on January 29<sup>th</sup>, when the mean temperature rose to 10°F.



### Impact of Below Zero Temperatures on Attendance Rates

The table below shows the coefficients that indicate the effect of the temperature falling below 0°F on daily attendance rates. By comparing the coefficients, we can see how extreme cold affects different groups in different ways.

Group	Below zero
Total	<b>-1.6%***</b>
African-American	<b>-3.4%***</b>
Hispanic	<b>-2.5%***</b>
White	<b>-0.6%*</b>
Free/Reduced	<b>-2.9%***</b>
Not Free/Reduced	-0.4%

Note: Statistically significant coefficients appear in **bold**. \*= $p < 0.10$ , \*\*= $p < 0.05$ , \*\*\*= $p < 0.01$ .

This table shows that being below 0°F is associated with a 1.6 percentage point reduction in attendance overall. This effect is much greater for African-American students (3.4%), Hispanic students (2.5%), and students receiving free/reduced lunch (2.9%). Meanwhile, the effect for white students is much smaller and the effect for students not receiving free/reduced lunch is not statistically significant. This suggests that extreme cold has a disproportionate impact on the attendance of students who are African-American, Hispanic, or receiving free/reduced lunch.

We also wanted to consider the effect of temperature on attendance in terms of degrees, modeled as degrees below freezing (32°F), as opposed to simply whether the temperature was below 0°F or not. However, a temperature decrease from 32°F from 22°F likely would not have the same effect as a decrease from 0°F to -10°F, and we would want to treat these decreases differently when estimating impacts. To do so, we developed regression models using degrees Fahrenheit below freezing squared (to model additional degrees below freezing as having a greater impact the colder it gets) as the variable of interest. These regressions yielded similar conclusions about the varied effect of cold weather on different student groups as those using the below zero indicator variable; white students and students not receiving free/reduced lunch were less affected than their peers who were African-American, Hispanic, and/or receiving free/reduced lunch. We choose not to present the associated coefficients in this report because they are not easily interpreted.

### Conclusion

Altogether, the data indicates that extreme cold affects student groups in different ways, with students who are African-American, Hispanic, and receiving free/reduced lunch less likely to attend school than their counterparts who are white and/or not receiving free/reduced lunch. Still, attendance was around 75% on the two case study days highlighted as examples of remaining open during extreme cold and above 50% for all student groups, suggesting that remaining open allowed MMSD to serve a large number of students.