1
00:00:04,160 --> 00:00:06,479
[MUSIC]

2
00:00:06,479 --> 00:00:12,179
Hello and welcome to Open Science.

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00:00:12,179 --> 00:00:16,650
I’m Dr. Marshall Porterfield, and today
we will be discussing the impact of sex and

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00:00:16,650 --> 00:00:19,560
gender on adaptation to space.

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00:00:19,560 --> 00:00:24,860
Joining me today in this discussion, a distinguished
panel: Dr. Graham Scott, to my left, from

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00:00:24,860 --> 00:00:29,869
the National Space Biomedical Research Institute;
NASA’s senior medical advisor, Dr. Saralyn

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00:00:29,869 --> 00:00:34,610
Mark; and from the Human Exploration and Mission
Operations Directorate, Dr. Bette Siegel.

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00:00:34,610 --> 00:00:39,730
Now that--together, as a team, you’ve been
working with other investigators to study

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00:00:39,730 --> 00:00:46,800
and better understand the role of impact of
sex and gender in space flight adaptation.

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00:00:46,800 --> 00:00:51,500
So, what are some of the key findings from
your studies, just off the top?

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00:00:51,500 --> 00:00:58,870
Firstly, Marshall, let me say that both women

and men do very well in space.

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00:00:58,870 --> 00:01:04,530
Having said that, we do see some differences--some
of these are very subtle and others are more

13
00:01:04,530 --> 00:01:05,530
pronounced.

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00:01:05,530 --> 00:01:13,050
For example, the majority of the astronauts
are now having some visual impairment issues.

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00:01:13,050 --> 00:01:18,820
Most--in most cases, these are mild, really,
just involving a change in the prescription

16
00:01:18,820 --> 00:01:25,680
that an astronaut might need in her or his
eyeglasses, you know, one to two months, let's

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00:01:25,680 --> 00:01:27,060
say, into the mission.

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00:01:27,060 --> 00:01:32,190
But, in a minority of cases, maybe in about
20% of the cases, we're seeing more significant

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00:01:32,190 --> 00:01:37,989
issues with the eyes, and these could involve
changes in, actually, the shape of the eyes

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00:01:37,989 --> 00:01:42,190
that don't even fully resolve when the astronauts
return to Earth.

21
00:01:42,190 --> 00:01:45,530
And we're seeing these more pathological
changes.

22
00:01:45,530 --> 00:01:48,690
We’re seeing those only in the male astronauts.

23
00:01:48,690 --> 00:01:54,259
The other area where there are some quite
significant differences is in the ability

24
00:01:54,259 --> 00:02:00,520
of our male and our female astronauts to spend
time in space, and this is due to the radiation

25
00:02:00,520 --> 00:02:03,130
limits that NASA imposes on the astronauts.

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00:02:03,130 --> 00:02:10,170
So, our female astronauts can spend significantly
fewer days in space because, based on ground

27
00:02:10,170 --> 00:02:18,440
studies and based on data that’s been collected
over several decades, it’s been prognosticated

28
00:02:18,440 --> 00:02:22,710
that the female astronauts are more susceptible
to cancer.

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00:02:22,710 --> 00:02:30,030
And NASA has set a very strict limit of only
having a 3% increased risk of cancer due to

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00:02:30,030 --> 00:02:33,290
time in space over the course of an astronaut’s
lifetime.

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00:02:33,290 --> 00:02:37,550
So, there’s a couple of examples of where
we do see some significant differences in

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00:02:37,550 --> 00:02:43,160

how our male and our female astronauts are
adapted to space flight.

33
00:02:43,160 --> 00:02:49,280
We also see interesting findings in the cardiovascular
realm, generally, women who respond to stress

34
00:02:49,280 --> 00:02:51,310
with an increase of heartrate.

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00:02:51,310 --> 00:02:55,930
Men tend to respond by clamping down their
vessels primarily due to hormones such as

36
00:02:55,930 --> 00:03:01,170
testosterone that causes that vasoconstriction,
that closing down of the blood vessel to maintain

37
00:03:01,170 --> 00:03:02,560
blood pressure.

38
00:03:02,560 --> 00:03:07,260
We see with many of our women, female astronauts
returning that they may experience what we

39
00:03:07,260 --> 00:03:09,180
call orthostatic hypotension.

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00:03:09,180 --> 00:03:14,690
And what that means is a drop in blood pressure,
which puts them at risk for fainting.

41
00:03:14,690 --> 00:03:19,630
And it’s primarily due, we believe, to these
changes in volume as well as how we respond

42
00:03:19,630 --> 00:03:20,710
to stress.

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00:03:20,710 --> 00:03:25,350
Men and women respond differently in their vasculature.

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00:03:25,350 --> 00:03:29,150
What we did is we looked at things that we see here on Earth and tried to see if we would

45
00:03:29,150 --> 00:03:30,150
see them in space.

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00:03:30,150 --> 00:03:35,090
So, we know, on Earth, we usually see women, especially as they get older, developing osteoporosis.

47
00:03:35,090 --> 00:03:36,380
Their bones lose calcium.

48
00:03:36,380 --> 00:03:40,790
But, when we looked at the data to see what we would see in space, we actually didn't

49
00:03:40,790 --> 00:03:42,210
see a gender effect.

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00:03:42,210 --> 00:03:44,080
We didn't see a difference between the male and female.

51
00:03:44,080 --> 00:03:46,410
It was all over the place, basically.

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00:03:46,410 --> 00:03:51,010
Yeah, and what Bette's alluding to is that there are a lot of personal differences.

53
00:03:51,010 --> 00:03:56,991
So, we're now living in this era of precision medicine, and what we see is that there are

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00:03:56,991 --> 00:04:01,810
very individualized responses to the space
flight environment.

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00:04:01,810 --> 00:04:07,569
To add onto what Bette's saying, some people
actually come back with increased muscle mass

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00:04:07,569 --> 00:04:12,530
relative to the muscle mass that they had
when they left to go up onto the International

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00:04:12,530 --> 00:04:17,940
Space Station for six months, and others come
back with somewhat less muscle mass or bone

58
00:04:17,940 --> 00:04:18,940
mass.

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00:04:18,940 --> 00:04:26,070
So, there are real opportunities to tailor
countermeasures to each astronaut and really

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00:04:26,070 --> 00:04:33,570
invoke this whole new approach of personalized
medicine to really make everyone's stay

61
00:04:33,570 --> 00:04:37,340
in space as healthy and as productive as possible.

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00:04:37,340 --> 00:04:42,060
What we saw--and we had six work groups looking
at how the human body adapts to space.

63
00:04:42,060 --> 00:04:48,270
So, those work groups included cardiovascular,
neurosensory, reproductive, immunological,

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00:04:48,270 --> 00:04:52,810

behavioral, and certainly, reproductive has
been traditionally what we viewed, but we

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00:04:52,810 --> 00:04:56,150
went even well beyond that, and then, of course,
musculoskeletal.

66
00:04:56,150 --> 00:04:58,139
And we found difference throughout the body.

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00:04:58,139 --> 00:05:00,710
Now, the question is, is it statistically
significant?

68
00:05:00,710 --> 00:05:05,020
That may not be as much an issue in regard
to how does that translate to what we see

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00:05:05,020 --> 00:05:06,020
clinically?

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00:05:06,020 --> 00:05:10,900
I think what's exciting is, as we're increasing
our numbers of women flying, we'll have

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00:05:10,900 --> 00:05:11,900
a better database.

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00:05:11,900 --> 00:05:13,370
We'll be able to assess.

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00:05:13,370 --> 00:05:17,949
But, we have to keep in mind we're not looking
at who's faster, who's better, who's

74
00:05:17,949 --> 00:05:19,810
smarter, who's better able to adapt.

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00:05:19,810 --> 00:05:24,150

What we're doing is trying to understand
what we're seeing so that we can develop

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00:05:24,150 --> 00:05:28,280
the appropriate countermeasures, develop the
appropriate equipment so that we can keep

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00:05:28,280 --> 00:05:32,270
both men and women healthy in space and when
they return to Earth.

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00:05:32,270 --> 00:05:36,449
And that's really a very important point
because for our future exploration missions

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00:05:36,449 --> 00:05:39,930
are going to be men and women, and so we need
to make sure.

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00:05:39,930 --> 00:05:44,590
We need to study it so that we know that the
countermeasure to these changes that we see

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00:05:44,590 --> 00:05:49,139
in space are going to both protect men and
women, both while they're in space and when

82
00:05:49,139 --> 00:05:51,139
they return to Earth.

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00:05:51,139 --> 00:05:52,139
Very good.

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00:05:52,139 --> 00:05:54,080
It's a really fascinating area.

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00:05:54,080 --> 00:05:58,630
And I noticed, though, in the title of your
primary publication that recently came out,

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00:05:58,630 --> 00:06:02,870
you made the distinction of sex and gender,
using that term.

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00:06:02,870 --> 00:06:05,699
Can you explain to the audience why that's
important to make that distinction?

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00:06:05,699 --> 00:06:09,110
So, the institute of medicine has defined
sex as your biology.

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00:06:09,110 --> 00:06:10,780
Are you male or are you female?

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00:06:10,780 --> 00:06:14,130
And gender is the way you respond in society,
and so we don't mean necessarily if someone's

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00:06:14,130 --> 00:06:15,130
gay or not.

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00:06:15,130 --> 00:06:18,480
What we're really looking at is, perhaps,
because you might be a female, maybe you're

93
00:06:18,480 --> 00:06:22,690
getting the same medical care that you might
get if you were male.

94
00:06:22,690 --> 00:06:27,600
And so, for example, on Earth, when people
have a heart attack, we know these symptoms.

95
00:06:27,600 --> 00:06:30,840
You might have crushing pain in your chest
and shooting down your arms, but that's

96
00:06:30,840 --> 00:06:32,139

really what men experience.

97
00:06:32,139 --> 00:06:38,290
Women, very often, experience fatigue, or
they may experience feeling an upset stomach,

98
00:06:38,290 --> 00:06:39,680
nauseous, or something.

99
00:06:39,680 --> 00:06:43,130
And so, when they go to the doctor, someone
may not check them out that see if they're

100
00:06:43,130 --> 00:06:44,220
having a heart attack.

101
00:06:44,220 --> 00:06:46,800
So, in our papers, that's how we use the
word gender.

102
00:06:46,800 --> 00:06:50,010
And, actually, after a while, the definitions
started to blend together more.

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00:06:50,010 --> 00:06:52,300
And then, I just want to follow up on that.

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00:06:52,300 --> 00:06:57,009
When the Institute of Medicine released the
report in 2001 entitled Does Sex Matter?

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00:06:57,009 --> 00:07:02,060
looking at the biological contributions to
health, they were very clear on how they define

106
00:07:02,060 --> 00:07:07,490
sex and gender--again, the psychosocial construct
implying gender, the biological chromosomal

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00:07:07,490 --> 00:07:12,440
implying sex--as we've evolved into the
world of precision medicine, as we've evolved

108
00:07:12,440 --> 00:07:16,900
into a world where we understand the influence
in genetics or human genome on our health,

109
00:07:16,900 --> 00:07:22,030
we've come into a space that we call epigenetics,
and that certainly influences how we live

110
00:07:22,030 --> 00:07:23,030
our lives.

111
00:07:23,030 --> 00:07:28,530
So, in a sense, as Bette has alluded to, the
definition, the delineation between sex and

112
00:07:28,530 --> 00:07:30,460
gender has become more of a continuum.

113
00:07:30,460 --> 00:07:35,990
But, we felt, for the nature of this paper,
we wanted to be a little more clear-cut, acknowledging

114
00:07:35,990 --> 00:07:40,680
that the environment influences the genome,
and the genome influences the environment.

115
00:07:40,680 --> 00:07:42,400
Very good.

116
00:07:42,400 --> 00:07:47,660
So, the data--the body of data that you used
for your study included both ground-based

117
00:07:47,660 --> 00:07:49,730
and space flight-based research.

118
00:07:49,730 --> 00:07:57,650
How does your study benefit us back on Earth
in terms of our medical technologies?

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00:07:57,650 --> 00:08:01,760
I think space is a fantastic platform to study
how the body adapts.

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00:08:01,760 --> 00:08:08,310
I'm a geriatrician endocrinologist, so I
see it as a model for, in a sense, accelerated

121
00:08:08,310 --> 00:08:09,310
aging.

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00:08:09,310 --> 00:08:11,910
The body adapts to space, and it adapts in
a way that is appropriate.

123
00:08:11,910 --> 00:08:16,270
The question is can the body readapt back
to Earth, and can we reverse some of the findings

124
00:08:16,270 --> 00:08:20,490
so that we can keep people healthy in space
and, certainly, when they return to Earth?

125
00:08:20,490 --> 00:08:24,669
I think what we have seen is that, as we just
alluded to, that there are changes in every

126
00:08:24,669 --> 00:08:25,669
system of the body.

127
00:08:25,669 --> 00:08:29,420
So, for example, we mentioned osteoporosis.

128
00:08:29,420 --> 00:08:34,539
Osteoporosis is a state of low bone mineral

density as well as what we call microarchitectural

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00:08:34,539 --> 00:08:38,789
deterioration meaning that the structure of
the bone can be impaired, and that puts you

130
00:08:38,789 --> 00:08:41,379
at risk for developing fractures.

131
00:08:41,379 --> 00:08:46,699
On Earth, 80% of those afflicted tend to be
women, and they're at high risk, certainly,

132
00:08:46,699 --> 00:08:51,230
for developing fractures, and men tend to
develop osteoporosis and fractures later on

133
00:08:51,230 --> 00:08:52,230
in life.

134
00:08:52,230 --> 00:08:57,389
So, as we study how the body adapts, how bones
adapt, how muscles adapt to space, we can

135
00:08:57,389 --> 00:09:02,600
learn appropriately how to prevent bone loss
and how to mitigate against that, and we can

136
00:09:02,600 --> 00:09:06,550
take those lessons and imply what we need
to keep people healthy on Earth.

137
00:09:06,550 --> 00:09:08,660
We see it, really, in every system of the
body.

138
00:09:08,660 --> 00:09:14,069
One of my other particular interesting favorites
to study is how the body adapts from an immunological

139
00:09:14,069 --> 00:09:15,329
perspective.

140
00:09:15,329 --> 00:09:19,319
We know, on Earth, women are more resistant
to infection.

141
00:09:19,319 --> 00:09:22,750
But, when they do get infected, they amount
very robust responses.

142
00:09:22,750 --> 00:09:28,139
When women are pregnant, they lose that resistance,
of course, so that they don't reject their

143
00:09:28,139 --> 00:09:29,139
fetus.

144
00:09:29,139 --> 00:09:31,069
In space, we know we have changes in the immune
system.

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00:09:31,069 --> 00:09:36,939
There's an altered immune expression to
microbes, to bacteria, to, really, everything

146
00:09:36,939 --> 00:09:38,870
that you're experiencing in your environment.

147
00:09:38,870 --> 00:09:39,870
And we want to see.

148
00:09:39,870 --> 00:09:43,889
Are we going to find those same findings in
space as we do on Earth?

149
00:09:43,889 --> 00:09:48,069
And, if so, how can we change that so people
can stay healthy in space?

150
00:09:48,069 --> 00:09:52,769
Again, every system of the body changes and
it has significant relevance to how we age

151
00:09:52,769 --> 00:09:54,610
and stay healthy here on this planet.

152
00:09:54,610 --> 00:10:00,149
I think space medicine can also be translated
to Earth in a couple of other contexts.

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00:10:00,149 --> 00:10:06,970
So, one is in the radiation area, so increasingly
now, the leading cancer hospitals are using

154
00:10:06,970 --> 00:10:13,800
particle therapy - proton therapy, and in
some parts of the world, using carbon ions.

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00:10:13,800 --> 00:10:20,649
And these are the types of particles, actually,
that are impacting our astronauts, that are

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00:10:20,649 --> 00:10:25,649
potentially causing damage in their cells
and to their chromosomes.

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00:10:25,649 --> 00:10:32,449
And so, by studying the effect of space radiation
on our astronauts, we may, actually, also,

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00:10:32,449 --> 00:10:38,420
in parallel, gain some insights to the effect
of this particle therapy that is now being

159
00:10:38,420 --> 00:10:42,839
therapeutically applied to patients here on
Earth.

160
00:10:42,839 --> 00:10:48,199
The other thing that I think is interesting
is that space--the space environment is the

161
00:10:48,199 --> 00:10:51,200
ultimate stressful environment in terms of
the human body.

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00:10:51,200 --> 00:10:55,879
The human body has not evolved to, necessarily,
to live in space, but yet, we can live there

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00:10:55,879 --> 00:10:58,029
very nicely.

164
00:10:58,029 --> 00:11:05,509
So, given that this is a stressful environment,
I think that the way the body adjusts both

165
00:11:05,509 --> 00:11:09,759
at a molecular level and also at a physiological
level can actually give us some really deep

166
00:11:09,759 --> 00:11:16,389
insights into how much stress we can actually
endure as a species and what actually happens

167
00:11:16,389 --> 00:11:20,809
as we go through those stressful situations,
again, in terms of our molecular responses

168
00:11:20,809 --> 00:11:23,660
and our physiological responses.

169
00:11:23,660 --> 00:11:29,170
So, just so that we have a better idea of
the scope of the work that you've accomplished

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00:11:29,170 --> 00:11:36,270

in this study, over what time period was the
data that you used collected, and what are

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00:11:36,270 --> 00:11:39,639
we talking about in terms of population of
subjects, astronauts?

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00:11:39,639 --> 00:11:45,750
So, we looked at the data from 1998 to about
2013 because that's when we finished our

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00:11:45,750 --> 00:11:50,369
study, but actually, there were studies and
reports done that were even prior to 1998.

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00:11:50,369 --> 00:11:54,749
So, we were looking at the shuttle astronauts
and the astronauts that were on space station.

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00:11:54,749 --> 00:11:58,800
This included the U.S. astronauts as well
as the astronauts of the partners.

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00:11:58,800 --> 00:12:03,899
And, at that time, during that time period,
when you looked at the total number of astronauts,

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00:12:03,899 --> 00:12:06,779
women were about 20% of the astronaut core.

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00:12:06,779 --> 00:12:12,569
The good thing is we're moving in the right
direction as the last astronaut selection

179
00:12:12,569 --> 00:12:14,750
was eight astronauts - four men and four women.

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00:12:14,750 --> 00:12:19,660
And the reason that's important to us is,
as a scientist, I want to see things that

181
00:12:19,660 --> 00:12:21,239
are statistically significant.

182
00:12:21,239 --> 00:12:26,029
And, in order to do that, you have to increase
the N. And so, if we fly more women, we can

183
00:12:26,029 --> 00:12:30,470
study more women, and then we can make sure
that the countermeasures we're developing

184
00:12:30,470 --> 00:12:33,839
will protect their health and the men's
health as well.

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00:12:33,839 --> 00:12:38,920
And I think what makes this program, what
we develop, this study exciting is that it

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00:12:38,920 --> 00:12:40,209
was a collaborative effort.

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00:12:40,209 --> 00:12:41,990
We had six work groups.

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00:12:41,990 --> 00:12:44,899
We had over 50 scientists working across the
country.

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00:12:44,899 --> 00:12:49,939
Not only did we develop the manuscripts, but
we also had a virtual workshop so that we

190
00:12:49,939 --> 00:12:53,410
could share our information with the general
public.

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00:12:53,410 --> 00:12:57,829

And it was very much a collaborative effort
and, hopefully, an ongoing effort.

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00:12:57,829 --> 00:13:02,989
As Bette has alluded to, we are, every day,
gathering new data both from our academic

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00:13:02,989 --> 00:13:07,459
partners and, certainly, within NASA and our
other agencies that we work with so that we

194
00:13:07,459 --> 00:13:12,549
can better ascertain sex and gender differences
so, again, that we can develop the appropriate

195
00:13:12,549 --> 00:13:16,889
products, and policies, and programs to take
care of our astronauts on Earth and when they

196
00:13:16,889 --> 00:13:18,839
return to space.

197
00:13:18,839 --> 00:13:23,079
Obviously, this is an important new study.

198
00:13:23,079 --> 00:13:28,529
It has importance and significance in terms
of how we plan and operate the Human Research

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00:13:28,529 --> 00:13:29,980
Program in the future.

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00:13:29,980 --> 00:13:34,639
How have you been working with the Human Research
Program and conducting this study, and what

201
00:13:34,639 --> 00:13:35,639
are your recommendations?

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00:13:35,639 --> 00:13:36,639
Yeah.

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00:13:36,639 --> 00:13:41,060
So, the Human Research Program has taken a
really strong interest in this study.

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00:13:41,060 --> 00:13:46,660
And, as Dr. Mark just mentioned, a number
of the investigators that were authors on

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00:13:46,660 --> 00:13:51,629
the various paper that were published, they're
actually funded, in many cases, by the Human

206
00:13:51,629 --> 00:13:52,629
Research Program.

207
00:13:52,629 --> 00:13:55,019
So, there are a lot of touch points.

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00:13:55,019 --> 00:14:00,139
A number of the aspects, in fact, the majority
of the aspects that were looked at in terms

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00:14:00,139 --> 00:14:05,809
of musculoskeletal health or cardiovascular
health, these impinged directly on some of

210
00:14:05,809 --> 00:14:13,259
the major risks that the Human Research Program
is seeking to mitigate, to close technology

211
00:14:13,259 --> 00:14:17,670
gaps, and to develop countermeasures for.

212
00:14:17,670 --> 00:14:23,939
So, I mentioned earlier in the conversation
this visual impairment issue.

213
00:14:23,939 --> 00:14:28,069
This is the number one risk to human health
in lieu with all that.

214
00:14:28,069 --> 00:14:34,129
And so the Human Research Program is keenly
interested in better understanding this visual

215
00:14:34,129 --> 00:14:40,540
impairment issue - how to fix women, how to
fix men, why there appear to be some differences.

216
00:14:40,540 --> 00:14:44,759
That could actually really give us a clue
to what's going on at a molecular or at

217
00:14:44,759 --> 00:14:47,029
a physiological level.

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00:14:47,029 --> 00:14:52,100
Why are no women currently having these more
clinically significant symptoms?

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00:14:52,100 --> 00:14:59,449
That could actually be a big clue in terms
of solving the underlying mechanism of what's

220
00:14:59,449 --> 00:15:03,399
causing this visual impairment, and then,
ultimately, leading to a countermeasure.

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00:15:03,399 --> 00:15:07,600
So, absolutely, the Human Research Program
and the organization that I work for, the

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00:15:07,600 --> 00:15:13,980
National Space Biomedical Research Institute,
we're very much involved in architecting

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00:15:13,980 --> 00:15:16,000
and participating in the study.

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00:15:16,000 --> 00:15:24,420
And now, the flow on effect is that there's
an increasing impetus to involve roughly equal

225
00:15:24,420 --> 00:15:31,069
numbers of males and females in Human Research
Program and NSBRI funded studies.

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00:15:31,069 --> 00:15:38,459
Now, it isn't possible in every single case,
but there's a real ground swell, if you

227
00:15:38,459 --> 00:15:39,459
will.

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00:15:39,459 --> 00:15:47,449
And this has been seen in solicitation documents
as well to really try to get, as Dr. Siegel

229
00:15:47,449 --> 00:15:53,420
said, enough female and enough male subjects
that you can really start to look for these

230
00:15:53,420 --> 00:15:54,420
trends.

231
00:15:54,420 --> 00:15:57,629
And then, ultimately, the goal is to build
countermeasures for our females and for our

232
00:15:57,629 --> 00:16:02,009
male astronauts, and also to develop these
again, going back to what I said earlier,

233
00:16:02,009 --> 00:16:05,189
for--on a personalized basis and on an individualized
basis.

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00:16:05,189 --> 00:16:07,920
So we had--oh, I'm sorry.

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00:16:07,920 --> 00:16:12,550
We had six teams, basically, and I just wanted
to say, in each team had a chair and a co-chair.

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00:16:12,550 --> 00:16:17,329
And the chair usually was a NASA expert meaning
they're NASA or NSBRI.

237
00:16:17,329 --> 00:16:22,519
So, there were people from HRP, and then the
co-chair would be someone who had an expertise

238
00:16:22,519 --> 00:16:24,310
in sex and gender research.

239
00:16:24,310 --> 00:16:28,559
And then, the team members were about six
to ten people, and they were, again, divided

240
00:16:28,559 --> 00:16:29,759
up like that.

241
00:16:29,759 --> 00:16:34,209
I just want to follow up when we talk about
how do we assess the data?

242
00:16:34,209 --> 00:16:39,720
Traditionally, we have used statistical significance
as being the ultimate goal, the gold standard.

243
00:16:39,720 --> 00:16:44,139
What we have learned from the national institutes
of health who've implemented a policy since

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00:16:44,139 --> 00:16:49,850

1993 through their NIH revitalization act,
that they needed to include male and female

245
00:16:49,850 --> 00:16:54,209
subjects in their studies unless there is
a particular reason why they should not be,

246
00:16:54,209 --> 00:16:57,540
that you don’t actually need statistical
significance to determine value.

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00:16:57,540 --> 00:17:00,649
They’ve moved into a space that we call
valid analysis.

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00:17:00,649 --> 00:17:05,740
Dr. Scott has mentioned trends, and we can
learn a lot from that.

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00:17:05,740 --> 00:17:10,360
I think it helps our researchers to know that
they don’t have to have exorbitant numbers.

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00:17:10,360 --> 00:17:14,329
It doesn’t have to be financially draining,
but they do have to have sufficient numbers

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00:17:14,329 --> 00:17:16,440
so that we can do the valid analysis.

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00:17:16,440 --> 00:17:21,170
We’re also moving into a time where we’re
looking at preclinical, so meaning we can

253
00:17:21,170 --> 00:17:26,930
study what happens in the cell culture as
well as animal studies to give us insight.

254
00:17:26,930 --> 00:17:29,530
We look at ground-based studies, what happens

here on Earth.

255
00:17:29,530 --> 00:17:31,140
We also have flight-based studies.

256
00:17:31,140 --> 00:17:32,140
We work with animals.

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00:17:32,140 --> 00:17:33,960
We work, of course, with humans.

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00:17:33,960 --> 00:17:37,670
And, I think, when you look at the compendium
data from both those environments and all

259
00:17:37,670 --> 00:17:42,730
the various study subjects, you can make a
best assessment of how the human body and

260
00:17:42,730 --> 00:17:48,020
the animal body adapts and what we need to
do to keep people healthy.

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00:17:48,020 --> 00:17:54,310
So, it’s well aware the agency has a goal
of performing a human mission to Mars at some

262
00:17:54,310 --> 00:17:55,310
point.

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00:17:55,310 --> 00:18:01,870
What are your recommendations from your study
with regards to Mars architecture for human

264
00:18:01,870 --> 00:18:02,870
exploration?

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00:18:02,870 --> 00:18:07,530
We had five robust recommendations, and if

you were to drill down, the bottom line is

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00:18:07,530 --> 00:18:13,240
we need to include more women and more men
to fly and to conduct experiments both on

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00:18:13,240 --> 00:18:19,260
Earth and in space, and that sex and gender
is incorporated into all our experiments and

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00:18:19,260 --> 00:18:20,580
what we do.

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00:18:20,580 --> 00:18:24,260
And that will certainly influence, again,
the policies that we draw up, the products

270
00:18:24,260 --> 00:18:29,120
that we need to have so people can live in
space, the educational programs that we need

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00:18:29,120 --> 00:18:34,500
to provide to our astronauts and to the people
that work with them to ensure that everyone

272
00:18:34,500 --> 00:18:40,810
has the best opportunity to live and work
safely and with quality in space and on Earth.

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00:18:40,810 --> 00:18:45,380
I want to take the opportunity to thank you
all for joining me today.

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00:18:45,380 --> 00:18:50,880
This is really a fascinating topic, and it's
very important to the agency and to the future

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00:18:50,880 --> 00:18:52,070
goals of the agency.